WORLD PETROLEUM

NEW YORK AND LONDON

FEBRUARY 1938

PURE OIL—AN INTEGRATED BUSINESS

ANALYSIS OF WORLD CRUDE PRODUCTION

U. S. EXPORTS IN 1937

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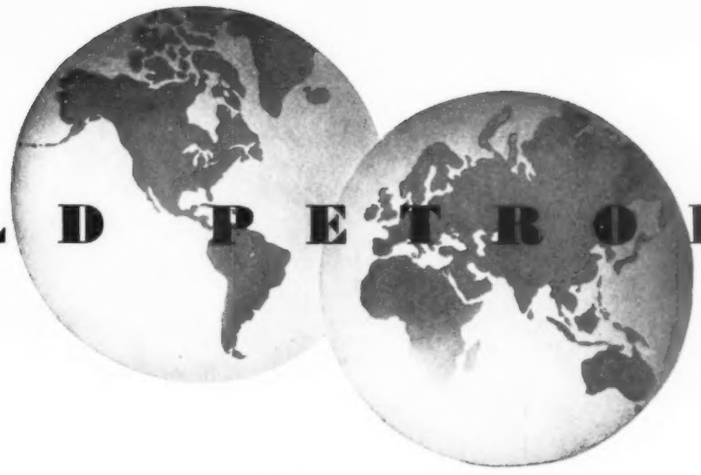

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RUSSELL PALMER
Publisher

E. W. Mayo
Editor

T. Orchard Lisle
Executive Editor

E. W. Mayo, Jr.
Managing Editor

S. J. Gallay
Advertising Manager

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CORRESPONDENCE

ADDRESS all correspondence regarding subscription and business matters to the Home Office; 95 River Street, Hoboken, N.J.

Editorial and Advertising offices; 56 West 45th. Street, New York, N.Y. London office; 3 Savoy Place, Victoria Embankment, W.C. 2. Los Angeles office; 412 West 6th Street.

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EDITORIAL

CONVICTION AT MADISON

A STORM of criticism has appeared in the press since the conclusion of the recent trial at Madison which resulted in the conviction of sixteen oil companies and thirty individuals. Yet, in fairness to the twelve honest men who brought in the verdict of guilty, one must consider the case from their viewpoint.

These men, far removed from the active operations of the oil industry and totally unfamiliar with its conditions, were asked by the defense to believe an incredible claim, namely that the defendants were being prosecuted by one branch of the federal government for doing what they had been encouraged and urged to do by another branch of that same government. Everyone acquainted with the facts knows that claim to be true, but that made it no less difficult for the jurors to believe since much of the evidence supporting it was excluded from the trial.

The extent to which the Russianization of the United States government has extended is shown by the orders issued to the various departments in Washington forbidding officials or employees to talk with representatives of the defense in the oil suit unless a member of the Department of Justice's organization was present.

From a purely legal aspect the prosecution accomplished a remarkable feat in being able to shift the basis of its attack completely between the beginning and end of the trial without having its case thrown out of court. The original accusation was that the companies had purchased gasoline at fictitiously high prices, and by the connivance of the recognized reporting agencies, had caused these prices to be accepted and published as representing the current market. This claim fell to the ground when the defendant publications showed that their quotations were based entirely on tank car sales to jobbers and consumers and when it was further developed that almost all the buying by the accused companies was done at or below the lows of the published quotations. In their final arguments the government attorneys changed from a claim of fixed prices to the assertion that the transactions of the corporate defendants merely "affected" prices, while at the same time seeking to create the impression that the whole advance in and stabilization of prices during 1935 and 1936 was due to systematic purchasing of this fractionally unimportant part of the country's gasoline production.

As is well known to those familiar with conditions during the life of the National Industrial Recovery Act and following its invalidation, Secretary Ickes and other members of the Petroleum Administration viewed the oil situation with grave foreboding. They feared that the industry might revert at any moment to the waste and destruction of values that prevailed in 1933. To avert that danger, and not to settle petty local price wars, was the chief concern of Administrator Ickes and the other members of the Petroleum Administration, as well as of those members of the industry who undertook the stabilization activities that later formed the basis for their criminal prosecution.

In this whole picture no man presents a sorrier spectacle than Secretary of the Interior, Harold Ickes. Undoubtedly the Secretary believed thoroughly in the work of stabilization which he initiated and which he encouraged members of the oil industry to carry on after his direct authority ended. Undoubtedly too he was powerless to prevent the bringing of the suit. Had he come forward with a frank statement of the facts it might have meant his retirement from the Cabinet, but other Americans have been willing to suffer more than the loss of a job where a matter of principle was involved. The

real measure of the man is shown not only by his failure to speak out in this connection but by the fact that he has since enlisted in the campaign of vituperation directed toward all classes of business men.

Among the victims of the government's prosecuting zeal are a number of men who, on the evidence submitted, had not even a remote connection with anything that was done in the purchasing activities on which the suit was based. The crime of which they were really convicted was that of being prominent executives in relatively large corporations. The others must attribute their predicament to misplaced confidence in the good faith of the federal administration. In point of honor they are in an enviable position compared to the government officials responsible for their present plight.

GOVERNMENT BY DELIRIUM

In its broader connotations the Madison suit cannot fail to deepen the confusion in which the policies of the present federal administration and their relation to business, large and small, have become involved. General Hugh Johnson described the verdict as a victory for the chiseling ten percent in the petroleum industry. With his usual apititude for trenchant characterization, the blunt-spoken General expressed in a nutshell the opinion which must be shared by everyone conversant with the circumstances of this remarkable case. The only persons who can derive satisfaction from the decision at Madison are the numerically small group who have opposed every effort toward conservation and who believe, mistakenly we think, that they can profit by such waste and disorder as threatened ruin to thousands of small producers and refiners five years ago.

The former head of the National Recovery Administration did not apply quotation marks to the phrase, "the chiseling ten percent." He had no need to do so. President Roosevelt himself has made it familiar to the country in his diatribes against the small minority who menace the stability of industry and the balanced order which he has advocated in repeated public utterances.

Every blast against business that has been launched from the White House has been followed by assurances that it was not intended to apply to the whole community of industrialists but only to the few who, through selfish disregard of the public welfare, opposed efforts to improve the general situation and particularly to better the position of the small operator and the wage earner. Yet here we have the spectacle of the government, through its legal arm, bringing its strongest weapons to the aid of the disorganizers, the very element against which the administration has thundered most vociferously.

The oil suit adds one more example to the long record established by the federal administration of tearing down with one hand what it professes to be attempting to build up with the other. A spectacle not unfamiliar in the nursery is that of the urchin who builds his cardboard blocks to an impressive height and then, with whoops of delight, dashes the structure to the floor. But when this same amusing practice is applied to the management of a nation's affairs the effect is bound to be bewildering and is likely to prove disastrous.

It is this curious lack of consistency, the pursuit by different branches of the government of policies diametrically opposed, the sudden shifts in position of the executive authority, that has brought about the present state of confusion and bewilderment on the part of the American public, that is responsible for the loss of confidence so bitterly criticised in Washington, and that has led to the breakdown of the administration's plans for the betterment of the national economy after a brilliant beginning.

Coming, as it does, at the very time when the President, through conferences of his own and through others that he has recommended, is endeavoring to combat the forces of depression and disorder, the outcome of the recent trial necessarily must have a discouraging influence upon this movement. It is a clear warning to business men that if they act together to prevent the breakdown of orderly processes of production and trade, even though they do so with the approval or at the insistence of members of the administration itself, such action may become a weapon wielded against them by federal prosecutors whenever the mood of Washington and its political exigencies undergo a change.

How can any group of business men embark on plans of stabilization outlined by the federal administration when they know that in a few weeks or months they may be publicly pilloried and attacked by the administration's own spokesmen, accused of sabotaging its efforts at recovery or even find themselves in the dock accused of criminal conspiracy?

There is an analogy that fits the case of the administration's attitude toward business. Dr. Samuel Johnson, on visiting the London fish market, was impressed by the fact that the fishmongers who were engaged in skinning eels addressed the most profane and abusive language to their victims because the latter persisted in wriggling about and would not lie still under the process of having their skins removed.

THE PURE OIL COMPANY

Building an Integrated Business

Conservative, But Not Always Conventional, the Company Has Pioneered in Developing Important New Fields—Many in Eastern States—and Has Advanced by Planned and Rapid Steps to the Position of a Well-Balanced, Fully Integrated and Efficient Organization.

THERE are a multitude of ways in which a great industrial enterprise can be built, and the manner of building always leaves its imprint on the final structure. A sound company is never merely a patchwork of consolidations and acquisitions, but where new units become a part of it, they must be absorbed into a living organism. On the other hand, it is often necessary and often takes considerable time to precipitate out of the evolving structure those elements present at the beginning which later prove to be unessential.

In the growth of The Pure Oil Company, a number of other corporations were grafted upon the stem of the old Ohio Cities Gas Company. Their history is interesting, but is only incidental to that of the parent company. In 1925, it may be said that the period of growth largely by acquisition had definitely merged into the development of existing units.

In studying the history of large corporations, it will be found that emphasis is put by the management at one stage on the acquisition of properties by absorption; at another, on the development and growth of existing facilities; and at another, on current operations. There is no stage in the life of a perfect organization where all of these considerations would not be taken into account by the management with exactly the proper emphasis. Since no business organization has attained perfection, however, the history of every company will show that at times one phase of its operations, either through necessity or habit of mind, has been stressed at the expense of another.

In the following pages is outlined the acquisition and absorption period of The

Earliest Pure Oil refinery — at Cabin Creek, West Virginia, adjacent to Pure Oil's first discovery field. Now operating as one of the company's seven modern refineries.

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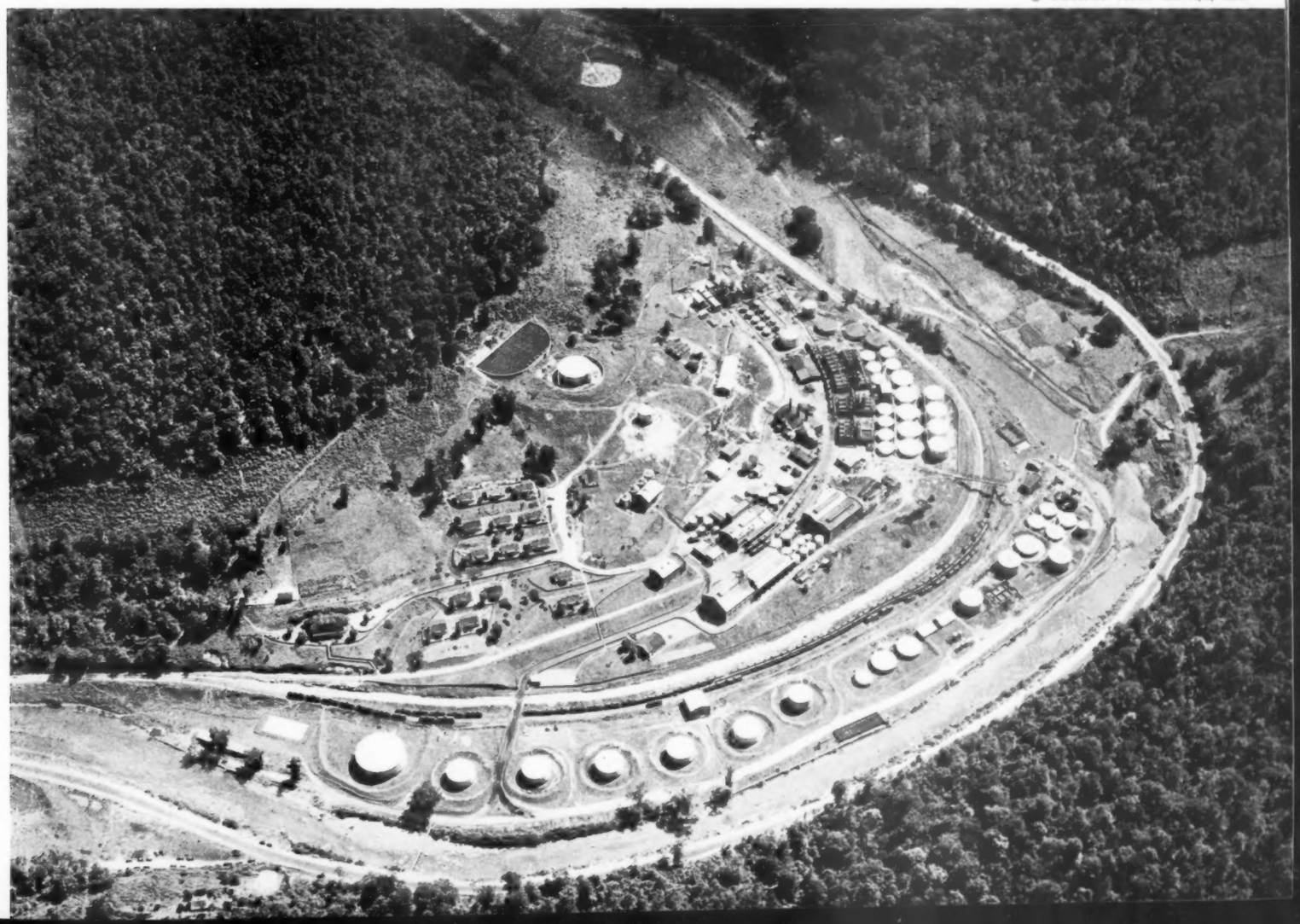


A section of the Van field, Texas. Developed on a unitized basis, it is one of the most valuable single oil fields in the United States.

Pure Oil Company before 1925 in contrast to the subsequent years, which were devoted more to the development of existing facilities with constantly greater attention to current operations. During the latter period many of the properties acquired before that time had to be developed to the point where they became efficient operating units and were assimilated. This necessity frequently required the subordination of current earnings.

The company's development has been brought about, not through the acquisition of new capital investment, nor altogether through plowing back earnings, in the ordinary use of the term. It is due rather to planning and policies which have resulted in a permanent, soundly built earning machine. In some years, this has entailed heavy burdens upon current operations. Now that the company has become a solid, integrated unit, the rewards for this far-sighted policy should begin to manifest themselves.

Up to 1925, The Pure Oil Company, then only ten years old, had undergone a rapid development. It had important production in the Mid-Continent and Texas, in Ohio and West Virginia. It owned pipelines, tankers and terminals. It had refineries in five states and was a marketer of products in various parts of the territory between the Atlantic seaboard and the Mississippi River.

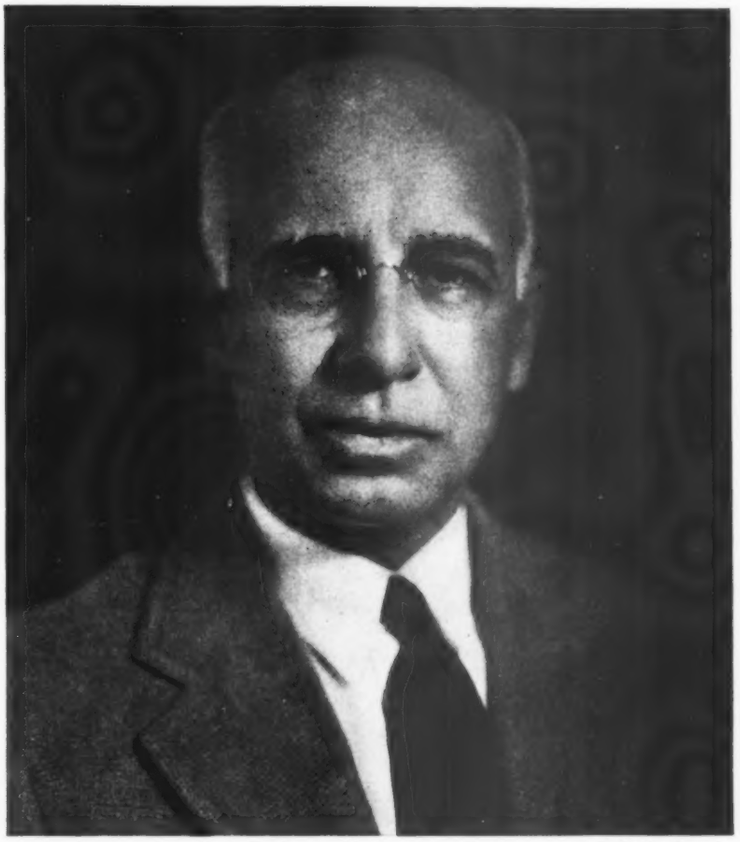
The date is important, because in the dozen years since 1925, Pure Oil has developed from a widely scattered, loosely related group of valuable properties to a fully integrated, closely coordinated and efficiently functioning company that is recognized as one of the leading independent petroleum organizations of the country. Its production and its reserves have been vastly increased. Its transportation facilities have been extended to unite its various parts into a homogeneous whole. Its refineries have been modernized at an expenditure of millions of dollars. Its marketing area has been extended into those territories where transportation costs give the company an advantage or at least equality with other suppliers.

As Pure Oil entered 1938, it found that in the twelve year period it had increased

crude reserves from 73,000,000 bbl. to a figure which may reasonably be estimated as at least 450,000,000 bbl. In the same period, gasoline sales—company branded products—through bulk plants, jobbers and service stations had been increased from 130,000,000 gal. to over 600,000,000 gal. annually.

Some large oil companies date their rise to greatness from the discovery of a flush field. Others, like the original Standard Oil Company, began as refiners and gradually extended their operations to production and marketing. At least one prominent company had a pipeline as a nucleus. The story of Pure Oil is like none of these. Its growth has been based primarily on production developed through discoveries of its own while on the marketing side it has expanded through judicious acquisitions of going properties.

While the history of Pure Oil is a business chronicle, it is not a commonplace business story. There was no lack of industrial romance and human interest in its early career though it is among the youngest of



Henry M. Dawes, president of The Pure Oil Company since 1924.

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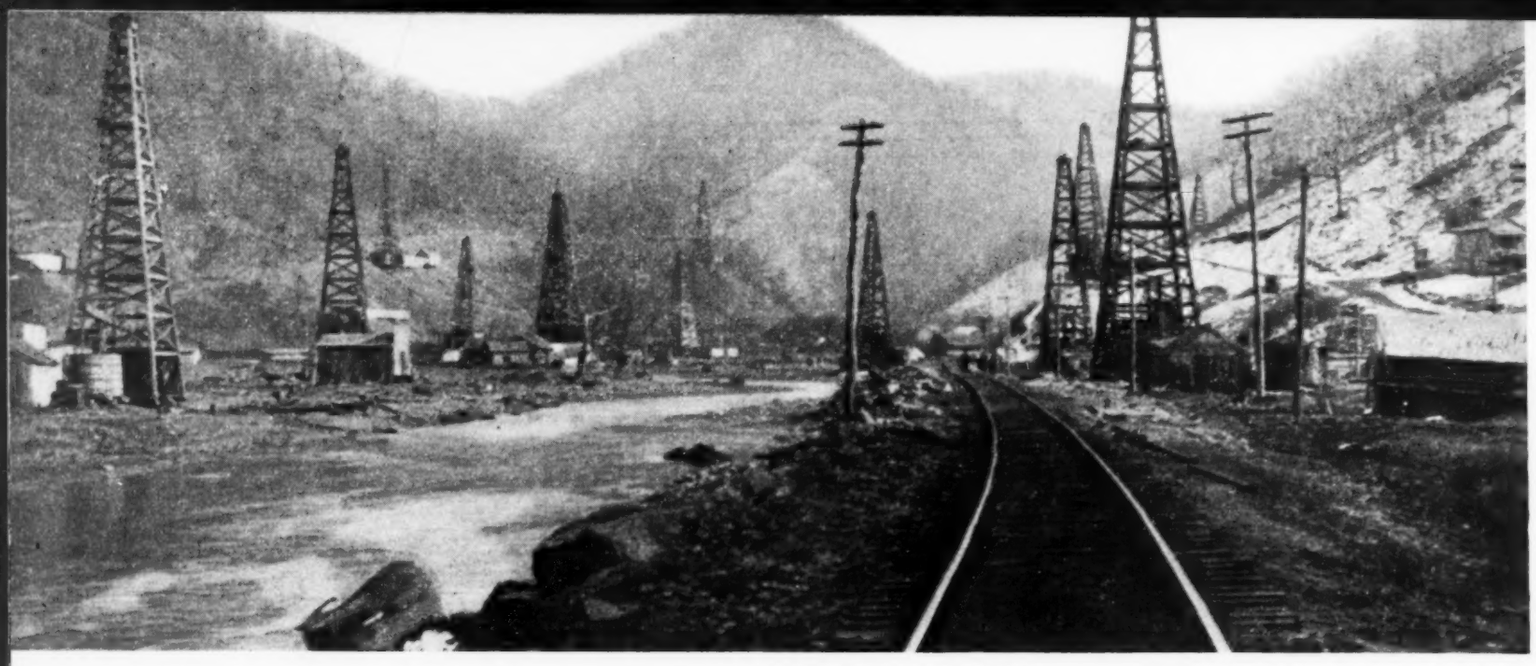
The Pure Oil Company's home offices in Chicago's Pure Oil building.

the big oil companies in the United States. Its corporate history really goes back nearly twenty-four years to the incorporation of the Ohio Cities Gas Company in April, 1914. The name, it will be observed, bore no resemblance to the present title and the company was not even in the oil business. It was formed as an outgrowth of the Columbus Production Company, headed by Beman G. Dawes, first president of the Pure Oil Company and now chairman of the board of directors.

Late in the day of December 18, 1914, when Mr. Dawes was on a business trip in New York, he received startling word from R. W. McIlvain, who was then associated with him in production matters, that oil had been struck that afternoon on some Ohio Cities leases in Cabin Creek, West Virginia. It was the Williams No. 1, producing a stream of golden crude, according to reports from Mr. McIlvain, now vice-president in charge of production for Pure Oil. The discovery well is still producing the famous Cabin Creek crude, while its owners have widened their production activities to eight other states. Mr. McIlvain is still in charge of the producing and exploratory operations of the company. During the twenty-four years in which he has occupied this position, he has discovered, in addition to the Cabin Creek field of West Virginia, the Van field of East Texas, the Sweet Lake, Gueydan and Louise fields of the Gulf Coast region, the Mt. Pleasant fields of Central Michigan and most recently the Noble, Clay City and Cisne pools of Southern Illinois. He has been an important factor in securing substantial company participation in such fields as Seminole and Edmond in Oklahoma, East Texas, Winkler, Goldsmith and McCamey in West Texas, Cooper, New Mexico, and the Bosco field of coastal Louisiana. Mr. McIlvain's record is so remarkable that he is universally recognized as one of the outstanding figures of America in his sphere.

The Cabin Creek field had resulted from a quest for natural gas, which caused the Ohio Cities Gas Company, controlling gas distribution in a number of Ohio communities, to obtain leases in localities judged favorable in Ohio and West Virginia. Before these leases could be developed, however, arrangements had been



Some of the first wells in famed Cabin Creek field.

made to obtain supplies adequate for the utilities' needs from another Ohio producer of natural gas. In order to maintain the validity of the West Virginia leases, it was necessary to drill two wells a year. As gas was no longer required, and if found would be more removed from the consumption centers than the supplies already contracted for, the company prospected for oil under Mr. McIlvain's direction. When the Williams No. 1 came in, it required no chemical analysis to disclose that it was the highest grade Pennsylvania crude, clear and transparent, and it was evident that the Cabin Creek holdings would be extremely valuable and productive.

Here indeed was a new future for Ohio Cities Gas Co., and plans were laid for the careful and systematic development of the field. The town of Dawes was established as a field headquarters, more wells were drilled, and in 1917, the Cabin Creek refinery, seven miles down the creek, and about 17 miles from Charleston, was completed and put into operation. In twenty-three years of operation, Pure's production at Cabin Creek has returned roundly $50,000,000 gross income to the company. The field is currently producing 900 barrels a day and still has several million barrels of recoverable oil.

EXPANSION— EAST AND WEST

Following its initial success in West Virginia the company developed extensive acreage in Ohio and brought in a number of producing wells there, becoming in fact the largest single producer in the state. In 1916, it moved far afield and purchased a group of leases in eight Oklahoma counties, aggregating 6,882 acres. These holdings were located in the Cushing, Nowata, Okmulgee, Osage, and other fields and had a daily production of about 5,000 bbl. The properties were bought primarily as an investment at a time when oil was selling cheaply and with the subsequent rise in the market they soon paid back the purchase price.

Then, in 1917, Ohio Cities Gas made the most important move of its career up to that time by purchasing outright for $23,000,000 the Pure Oil Company of New Jersey. By this transaction, it added to its holdings 1,727 producing wells in Illinois, Ohio, West Virginia, Louisiana, Oklahoma and Pennsylvania; a refinery at Marcus Hook, Pennsylvania; 1,195 mi. of pipeline, and 28 bulk plants.

Pure Oil Company of New Jersey had been in existence for more than twenty years at the time of the sale and had had a checkered and dramatic career. Its roots extended back to the time of the fight of the independent Pennsylvania producers against the big combination that was being built up by John D. Rockefeller. All this, of course, was long before the transaction which joined the fortunes of the company to those of Ohio Cities Gas. In 1917 the Pure Oil of New Jersey was a well-established, independent company with an extensive production, refining and distributing business, located in an area contiguous to that in which Ohio Cities Gas conducted its main operations. The combination of the two was a logical development.

Well launched on the road of expansion from a local to a national organization, Ohio Cities Gas continued to acquire other properties as favorable opportunities presented themselves. In 1919 it obtained control of the Oklahoma Producing and Refining Corporation with 85,000 acres of Mid-Continent leases, a daily production of 6,000 bbl., a refinery at Muskogee, Oklahoma, and a number of distributing outlets.

EXIT OHIO CITIES GAS

A significant event of 1920 was a change in the name of the company. Ohio Cities Gas Company for a number of years had been in the anomalous position of being neither a gas company nor supplying fuel to Ohio cities. It had acquired the right to the Pure Oil name through purchase of the company originally bearing it. It was a good name too, with a recognized standing among the trade in the eastern states. In the minds of veteran members of the industry it stood for courageous pioneering and sturdy defense of the rights of small producers. So, on July 1, 1920, the combination was chartered in Ohio as The Pure Oil Company. It has done business under that title ever since.

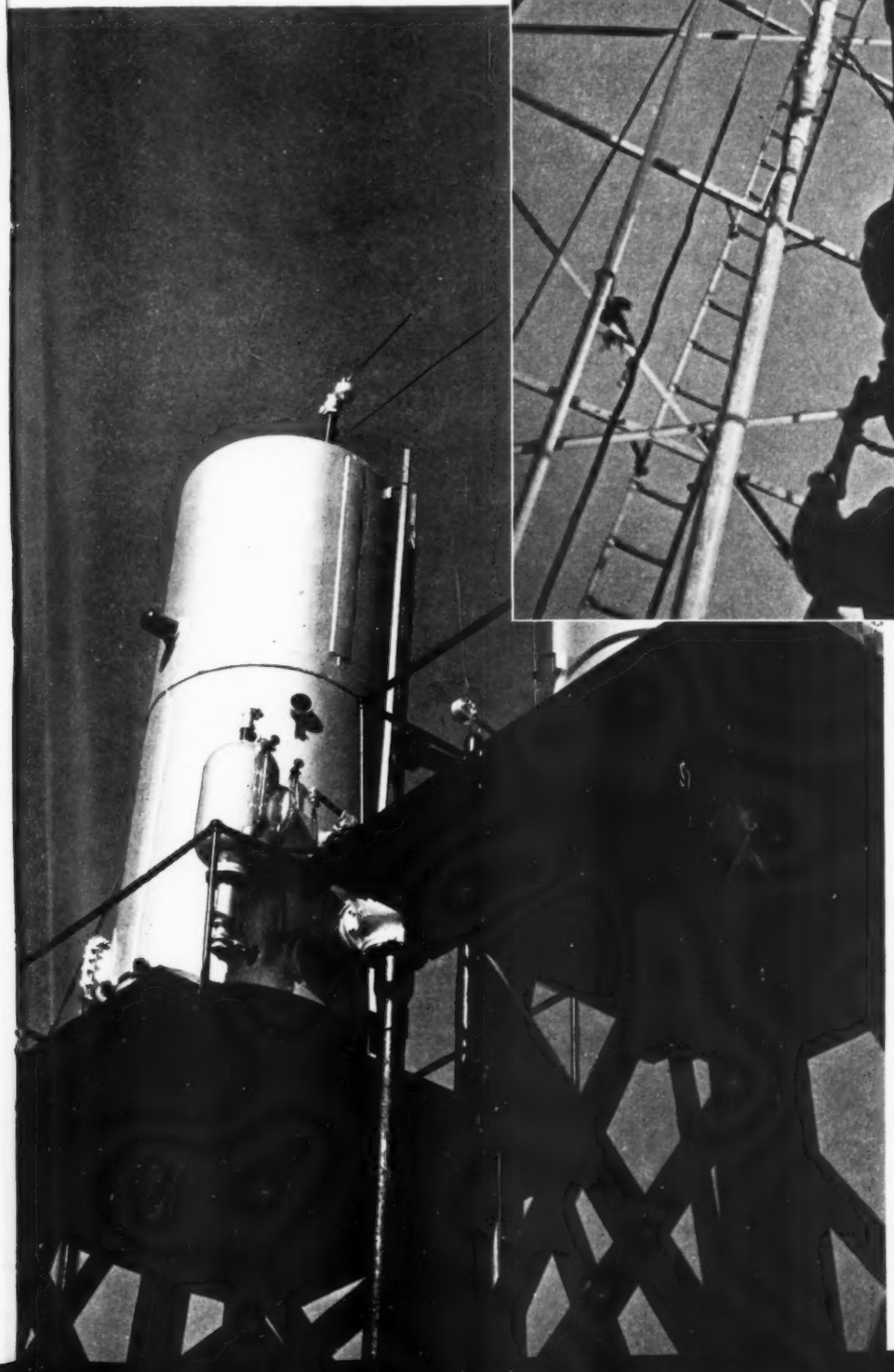
In 1921 Pure Oil Company purchased a third interest in the Humphreys Oil Company which controlled the Mexia, Texas, field. Two years later full control of the Humphreys interests was acquired. In the meantime a 210-mi. pipeline had been built from Mexia to Beaumont where large terminal facilities and a refinery site had been purchased. The refinery — Smiths Bluff—was completed late in 1923 with an initial daily capacity of 10,000 bbl.

Acquisition of the Humphreys properties was another landmark in the early history of Pure Oil because it gave the company a strong position in Texas which was then

well on its way to its present place as the nation's greatest producer of petroleum. A year later came important developments in the Powell and Wortham fields in Texas, in which Pure Oil held a large interest.

ENTER ERA OF INTEGRATION

This was the Pure Oil Company as it stood in 1924—a collection of profitable but widely scattered properties. They included 5000 wells, a large proportion of these being in highly productive fields in Texas and Oklahoma; the remainder in the older developed Appalachian area. The company owned nine refineries, four in the



Above, looking up the derrick from the floor of a Pure Oil drilling well, Southern Illinois. Left, gas separators in the Van field.

East, four in the Southwest, and one in the Northwest. Its transportation equipment included three ocean tankers, an extensive pipeline in Pennsylvania and shorter lines connecting its producing fields with shipping terminals and refineries.

On the marketing side the company had developed groups of service stations in Ohio and Pennsylvania and it had acquired a number of others, as well as bulk distributing plants, incidental to its purchases of other companies. In 1920 it had bought the Pure Oil Company of Minnesota which brought with it a small refinery and a

New giant pulling unit—first of its kind to travel on its own power—designed by Pure's engineers. Drum will spool 39,000 ft. of half inch sand line: can be converted into prime mover for rotary drilling rig.

group of marketing outlets in Minnesota, Wisconsin and other Northwestern states.

Here then, was the situation in 1925: The Pure Oil Company was a somewhat loose aggregation of consolidated companies built upon its first great valuable property, the Cabin Creek field in West Virginia. In the days following the world war, it had grown rapidly, and had spread far.

The problem before the company was that of co-ordinating its different holdings, filling in gaps, connecting its producing, refining, and distributing units by a comprehensive transportation system, and extending its marketing field to form a fully integrated, smoothly functioning organization. This is the problem that has been solved with brilliant success by the present administration. Not only has Pure Oil become one of the model operating companies of the country but it has greatly expanded its latent resources in reserves, has discovered and developed important new fields, has thoroughly modernized its refining equipment, has built up technical and research departments that are recognized as among the best in the country and has established an enviable reputation for its products.

This is a fairly full record of accomplishment for a dozen years. It has been attained through a systematic plan of business building, by steady adherence to the policy of foregoing an immediate showing of earnings to provide for further development, by careful advance planning of each succeeding move, and by a progressive policy of encouragement to employees in all departments that has won the enthusiastic cooperation of its workers, now grown to a family of many thousands.

Heading the company during the years of integration has been Henry M. Dawes, who succeeded his brother Beman G. Dawes, president of the company during pioneering and accumulation years. Henry Dawes came from his post as Comptroller of the Currency of the United States to Pure's presidency, although he was not a stranger to the oil business, having grown up in Marietta, Ohio, when discoveries of oil and natural gas were developing a new field of business opportunity in eastern Ohio. When he was barely out of Marietta College, he became president of Southern Petroleum Company. Before going to Washington, he had spent many years in the public utility business in Chicago. When, near the end of 1924, Henry M. Dawes took over the president's post, Beman G. Dawes assumed the position of chairman of the board.

Modestly, Henry M. Dawes refers to Pure Oil as a "small company." His unspoken pride as a business man undoubtedly is in its efficiency rather than in its size. But if Pure Oil is not to be ranked among the very largest of the country's petroleum units, it has reached a position of leadership among all except the few that are international in their scope. Pure Oil is wholly American. In recent years it has not sought to extend its operations beyond the nation's borders except for one holding of 61,000 acres in the Lake Maricaibo basin of Venezuela, owned by its subsidiary, the Orinoco Oil Company, and still in the preliminary stages of development.

In attempting to portray the policies and developments that have marked what may be termed the construction or integrating stage of the company's progress, as compared with the pioneering or formative stage preceding, it is difficult to follow a chronological order because activities have been proceeding on so many different fronts at the same time. In the interest of clarity the progress of the company will be described under the various divisions of production, transportation, refining, marketing, and research familiar to members of the oil industry.

Before entering upon these phases of the company's activities it may be mentioned, however, that in 1926 its general offices were removed from Columbus to Chicago. There, from the Pure Oil building, named in the company's honor, has been directed the work of building the company to a broader pattern as one of the country's great business enterprises and extending its operations to cover two-thirds of the United States.

INDEPENDENT COURSE IN EXPLORATION

Since crude oil is the life blood of the petroleum industry, the provision of supplies naturally receives a chief share of the attention of every integrated company. In its quest for additional production, as in other directions, Pure Oil has followed an unconventional but highly successful course. While its production in early years was augmented by purchases of developed or semi-developed areas, its matured policy has been to seek out new areas of its own, and to develop them independently or in

conjunction with some other single interest.

The procedure has some obvious advantages. If a highly productive field is located, the company derives a larger share of the returns from its investment in exploration. Moreover, where ownership is in the hands of a single company, or at most two or three, it is possible to drill and produce it on sound economic principles without the cost and waste of a large amount of competitive drilling. The life of the field is prolonged and maximum recovery of oil assured.

Pure Oil has been able to follow this plan of exploration successfully because of the size and ability of its geological staff and because it has been alert to adopt every scientific improvement that has been made in the methods of studying structures and determining their character.

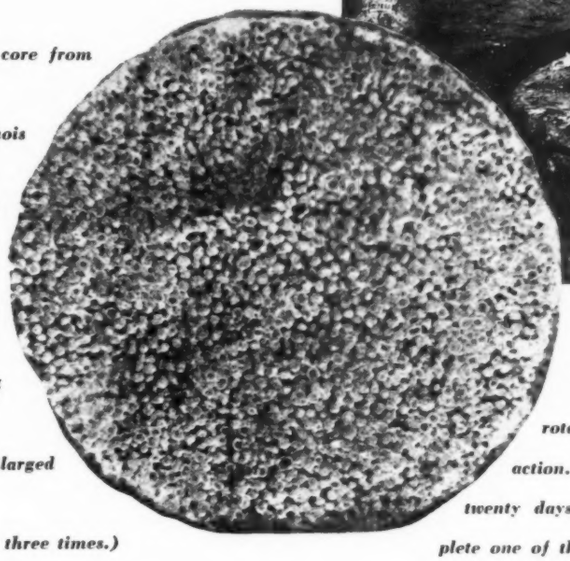
It will be recalled that in the very first discovery at Cabin Creek, the company played a lone hand. It uncovered a compact and highly profitable field which it developed with careful attention to the spacing and location of wells. As a result Cabin Creek, after twenty-three years, is still producing.

THE VAN FIELD

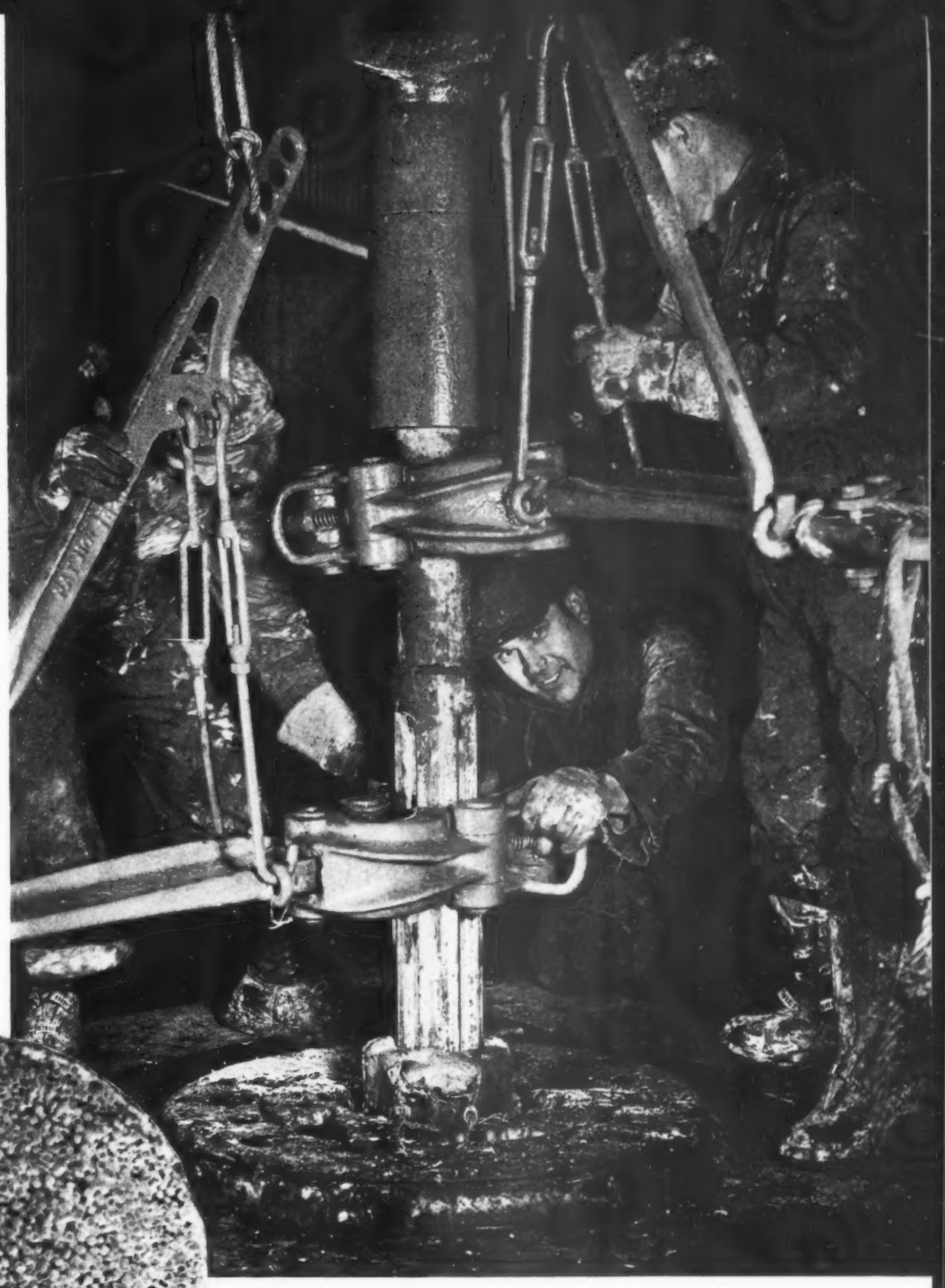
Many great oil fields, such as Ranger, Smackover and Winkler, were heralded by wildcat discoveries which blew oil and gas into the air, often out of control and on fire. Discoveries in such uncharted fields were quickly followed by a campaign of rapid drilling with wells producing to their limit. The Van field, in Eastern Texas, in which Pure again pioneered, has had none of these preliminaries, and since its discovery, October 14, 1929, has had a quiet, orderly, business-like development. Yet it is rated as one of the most valuable single oil properties in the country with the pay section, in this case Woodbine sand, from 500 to 600 ft. in thickness at the top of the dome.

It is difficult to realize the magnitude of of the Van field. In eight years 569 wells have been drilled throughout an area of 4,521 acres, with accumulated production approaching 111,000,000 bbl.

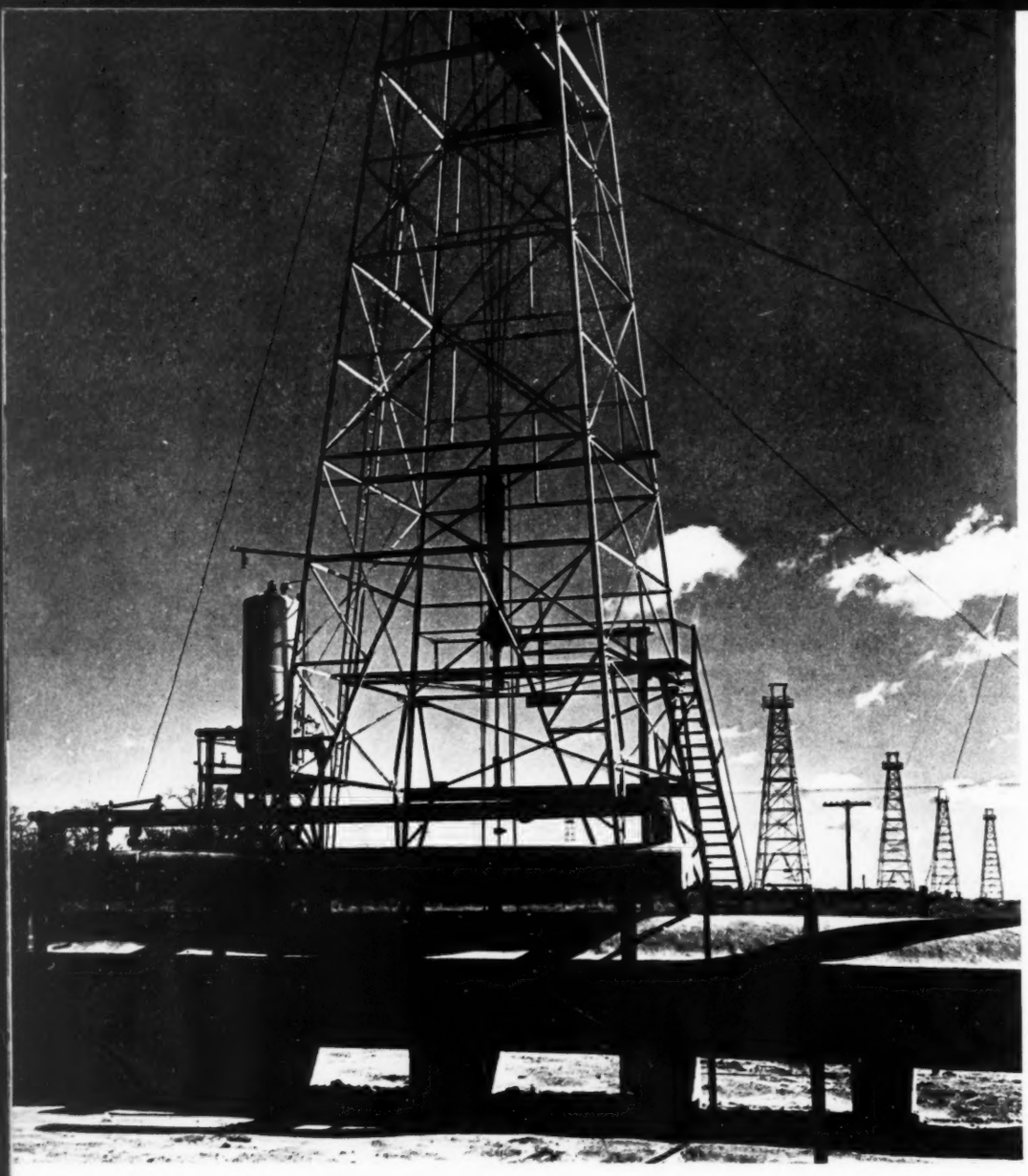
Average recovery per well to date at Van totals about 200,000 bbl. It has been estimated by production men that the field has not yet produced more than 25 percent of what may reasonably be estimated as its total recovery. At no other field in the world, it has been said, have wells consistently been so satisfactorily and scientifically produced.



Stone caviar: core from Southern Illinois discovery well showing oolitic producing formation. (Enlarged approximately three times.)



Southern Illinois rotary drilling crew in action. It requires about twenty days to drill and complete one of these wells.



Above, section of Van Field. Derrick in foreground has Sullivan pumping head device, making for economical production of oil.

In the spring of 1929, the town of Van had about 30 families. It lies among rolling, sandy hills, with oak trees and cotton patches in between. The area is relatively high as it is on the headwaters of the Neches River on a divide between the Neches and the branch streams which flow northward into the Sabine River. Van then was not on a railroad; the nearest large city is Dallas, some 60 mi. westward.

Much preliminary work was necessary by geologists before the blocking up of the leases in the Van area in the spring of 1927. The long process of preliminary survey, geophysical work and core drilling, which are necessary steps in modern oil exploration, proceeded in its conventional way at Van. About 17,000 acres were blocked up by the company, and the first well, the Jarman No. 1, demonstrated the presence of an oil field.

The Van field attracted caravans of oil field followers and entertainers, but their stay was comparatively short for the field was successfully unitized within 30 days after Jarman No. 1 was brought in. Pure Oil made an agreement with the owners of small leases in its block that it would drill and operate the field as a unit. Other companies holding leases in the unit were Humble, Texas, Sun, and Shell.

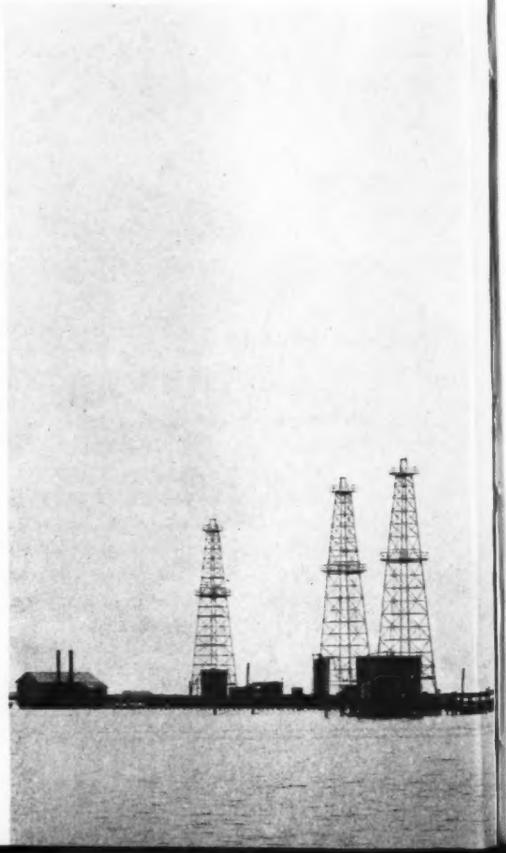
The agreement determined the limits of a unit to be operated under the direction of Pure Oil with the least possible expense, to eliminate overproduction and waste of resources, and to do this in a way that would have the effect of securing for the operators and the royalty owners their fair proportion of the total amount of oil in the pool. Oil does not stay put, but will travel from one piece of land or lease to another as wells are drilled. Consequently, after the discovery of almost all new oil fields, a race ensues, during which every operator drills wells as rapidly as possible to protect the supply under his own lease. There have been no wild drilling races in the Van field.

Much of the conventional drama of the oil business is absent in Van. Even derricks, the traditional landmark of an oil field, are few in number. There are orderly streets lined by neat and well-painted cottages occupied by company employees. There are machine shops, pipe yards and everything to create a self-contained operation, but the lost motion, the mud-holes, mired trucks, and the dissipation of money and morals, usually associated with a big flush field, are absent.

The Van field is spectacular only in its resources. The consolidation of development and operating efforts has resulted in great money savings to participants in the Van unit accounts. A minimum number of major equipment items are required; jointly owned powers can pump wells in all directions regardless of original ownership; well servicing crews can work over the entire block; quantity purchases can be made; there is one gas gathering system, one natural gasoline plant, one gas residue system, one fresh water system, one salt water disposal system, and central camps help effect other economies.

MICHIGAN FIELD

Up to twelve years ago oil men considered that Michigan offered little promise of substantial oil production. Surface and sub-surface records had been maintained



and studied, but not until 1926, when Pure's geologists stepped in, was it discovered that Michigan, in the center of an area of large gasoline consumption, held possibilities of developing into a major oil-producing district.

The first indication of oil in Michigan was in and around salt wells near Port Huron. These wells were not of commercial importance and, since they were located on the rim of the Michigan basin, they did not lead to exploration for oil. The wells were small, and such indications as they gave of oil reserves were not taken seriously.

The first commercial production in Michigan was discovered in the city of Saginaw, and brought on an extensive town-lot drilling campaign. The second discovery came three years later in Muskegon. Correlation of old brine wells, from which sub-surface maps were drawn, had been the forerunner of both discoveries.

Pure Oil geologists, in 1925, carried on extensive core-testing; in 1926, geological surveying went on intensively. In 1927, correlations on the Marshall horizon resulted in the discovery by Pure Oil of the Mt. Pleasant (Greendale) field, in which a pool was opened in 1928.

Because this pool was located in the approximate center of the Michigan basin the area had not been considered as favorable. By 1933, however, the Vernon, Leaton, East Greendale, Porter and Yost-Clark pools had been discovered.

By the end of 1937 the whole Michigan basin had received extensive wildcatting, and as a result of the sub-surface information thus developed, the Broomfield, Big Rapids and Six Lakes gas pools, and the Edmore, Crystal, and Buckeye and Sherman oil pools had been discovered.

The Pure Oil Company also developed core test information which led to the discovery of the West Branch pool.

All of the discoveries in Michigan fields have been the result of subsurface work. The deep drift which covers the basin makes exploration a problem of drilling holes, because there are no surface outcrops, and geophysical methods to date have not been very successful.

Pure was the first major company interested in Michigan on a large scale, but as soon as Pure proved that basin structures were productive, several other major companies became active there. Pure controls the Sherman and Yost pools, and holds a large percentage of the production along the Mt. Pleasant trend, in the Six Lakes gas pool and in the Crystal pool. The West Branch production was not as abundant as the Mt. Pleasant, and Pure's holdings were sold.

Pure's production in Michigan, in 1937, was 3,700,000 bbl., from 430 producing wells. Michigan, in a decade of operations, has produced over 80,000,000 bbl.

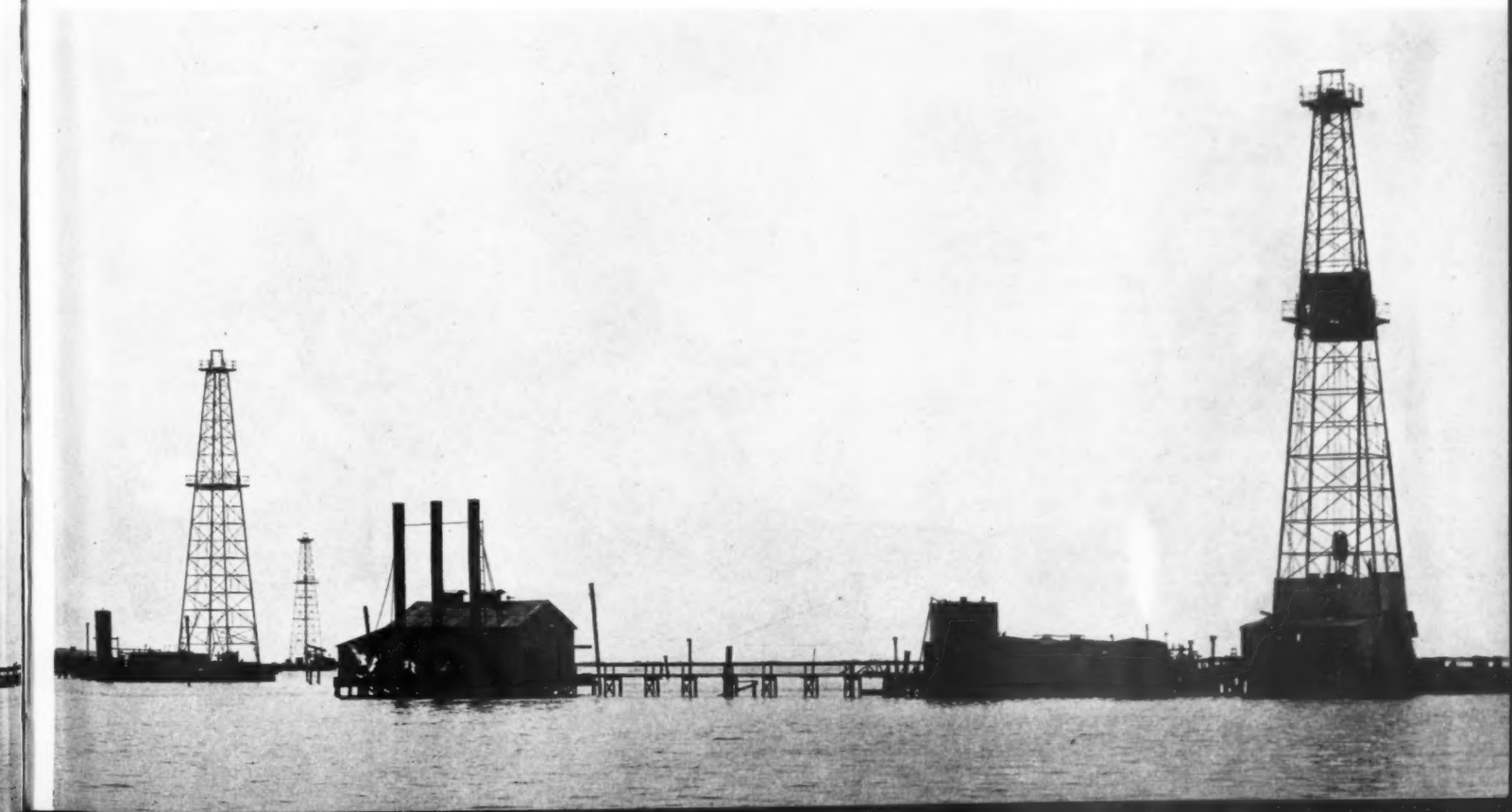
Oil production in Michigan has been chiefly from the Dundee (Devonian age) lime, although the Traverse (Devonian) and Berea (Mississippian) have also produced commercial quantities of oil. The gas has been from sands in the Michigan series and Marshall formations, both of Mississippian age. Depths drilled for oil average around 3,500 ft. and for gas around 1,300 ft.

NEW SOUTHERN ILLINOIS FIELD

Pure's newest noteworthy development will be a year old in March, 1938. It is the new southern Illinois basin, which holds the promise of making Illinois again an important petroleum state. Pure's always active geological department, with its special talent for finding oil, became interested in this area following the discovery of oil in Michigan in 1927.

The first step, in 1928, covered a broad area and resulted in preparing a cross section from Lawrenceville, Illinois, to St. Louis, Missouri, in which the published logs of old wells were used. This preliminary study showed a disturbance in the area between Flora, Illinois, and Olney, Illinois, but the suggested structural feature was not given great weight because of the chance for error in the logs. It was, however, as Pure's geologists have pointed out, a clue which led to the reconnaissance torsion balance survey made in 1930. This survey started at the Indiana line, crossed a portion of the old field and indicated a gravitational disturbance similar to that found on the south end of the La Salle anticline.

During 1935 and 1936, the success of the reflection seismograph in Oklahoma and Texas led to a survey by that method in the new Illinois area. By use of the latest methods, the seismograph work checked the existence of a structural disturbance running across Wayne, Richland, and Jasper counties in Illinois. During the first year of operations in the new basin, drilling has confirmed the geophysical work, and a drilling map of the area shows dry holes appearing outside the rim of the area



Sea-going wells in another Pure Oil discovery—Sweet Lake, Louisiana.

Wabash Pipe Line crew—Pure Oil subsidiary—welding sections of 8 inch pipe before placing line below surface near Noble, Illinois.

recommended for leasing on the basis of geological findings.

The structural feature along which the new pools are located appears to be an extension southwestward from the Oakland anticline.

Geologists familiar with the southern Illinois territory know that the relatively flat plain has a surface cover of glacial drift about 50 ft. thick, consisting of unconsolidated sand and clay left upon the retreat of the ice sheets which once covered it. This mantle of glacial material has covered the bed rock to such an extent that it is impossible to do any detailed surface mapping. The old southeastern Illinois fields—which are still producing—are on the La Salle anticline which has been outlined by drilling in the southeastern counties and by studies of rocks exposed on the surface near La Salle.

Early oil explorers venturing west from the fields of Crawford and Lawrence counties soon lost interest after drilling into salt water at depths comparable to those at which they found oil in the old fields. Few tests, it is pointed out, went lower than 2,000 ft. In the newly discovered area, production is coming from about 3,000 ft.

In developing the area, Pure's land agents assembled a block of 282,000 acres in southern Illinois beginning in April, 1936, and the drilling with cable tools of the first test came near Cisne, in Wayne County, with the second test following near Clay City in Clay County, some 12 miles north. These two tests discovered oil in sands of the basal Chester. However, with the introduction by Pure of rotary drilling in the area, deeper drilling at Clay City on the Bunyan Travis farm discovered the first production in the McClosky of the St. Genevieve, and this well's initial production was 2,644 bbl. per day through choke from a depth of 2,964 ft. More recently drilling has been extended to include other areas in Clay and Richland counties.

Principal production in the Illinois area is coming from the McClosky pay horizon found in the top of the St. Genevieve of Mississippian age. The McClosky is an oolitic limestone of varying porosity depending on the condition of the oolites. Wells which make big initial production are from oolitic layers which are soft and porous, and these porous spots quickly change into areas of dense, tightly cemented oolites.

At the end of a year's development, Pure has 112 wells producing in a belt over 20 miles long; 17 wells are drilling, and a pipeline has been constructed from Noble to Martinsville, connecting there with the Illinois Pipe Line system.

The old fields of Illinois have made their production from small, long-lived pumping wells, and geologists have pointed out that the same may be expected from the new fields, which are but 30 miles away.

Pure is taking full advantage in the new field of the great improvements in drilling and production technique developed within the industry, and its leadership in the area has brought almost boom conditions to this flat farming region. It is an area rather thickly settled by people whose pioneer

ancestors came into the region from Kentucky and Virginia. Outside of the rich corn belt of Illinois, these people have had to work hard to make a living from their 40 and 80 acre farms. Power machines such as tractors and combines have not been common. It has been difficult getting much from the soil, in this section which borders on Illinois' "Little Egypt." Years of plenty appear to be ahead.

While such fields as those in Illinois, Michigan, and the earlier one in West Virginia do not compare in initial volume with some of the flush fields of Texas and Oklahoma, they have a special importance from the fact that their output is usually a high gravity oil and that they are located close to leading markets so that the cost of transportation is kept down. It is noteworthy that Pure Oil Company, almost alone among the larger petroleum organizations in recent years, has given special attention to the development of crude supplies in the eastern states. Today, despite the large holdings of Pure Oil in other areas, a substantial portion of its production comes from wells east of the Mississippi.

While Pure Oil has made an unusual record in the development of production in eastern states, which had been almost abandoned as potential territory for oil, it has devoted great attention to those areas which are and probably will remain the country's principal reservoirs of petroleum. In 1935, it opened the important Louise pool and participated in the Goldsmith pools in Texas and the Edmond pool in Oklahoma. Production in the Van pool, the Bosco pool, the Graham Lake development in East Texas, the Cooper pool in New Mexico, and the Goldsmith pool in Texas and Kermit, Winkler County, Texas, has been developed jointly with other oil companies.

Other fields discovered and completely owned by Pure Oil Company are Sweet Lake and Gueydan in Louisiana.

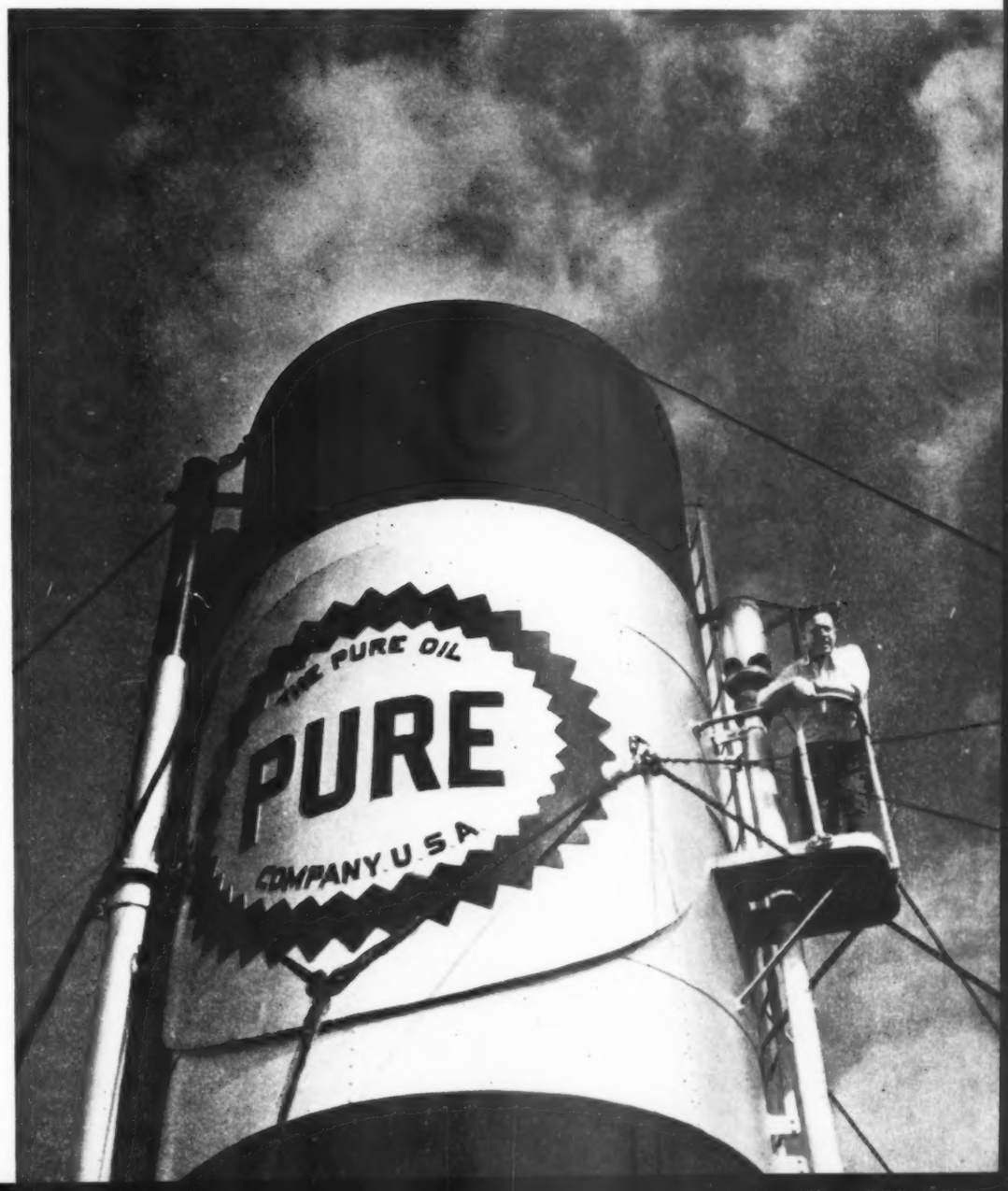
With all the expansion that has taken place in Pure Oil's holdings the restrictions imposed by state proration and by the requirements of sound conservation are such that the company has been a purchaser on balance and buys every year from 15 to 35 percent of the crude needed to supply its refining and marketing requirements. While this is at times a very severe burden upon the current earnings of Pure Oil, it nevertheless has very definite compensations. The oil in the ground in a unitized field is somewhat like a certificate of deposit at a bank, which represents real wealth but is not immediately available. Pure's potential production is so great that without the restrictions under proration, it could produce more than twice the amount of crude it needs for current sales for a great many years.

POLICY OF UNIT OPERATION

In looking over the record of Pure Oil Company on the production side, one cannot fail to note one outstanding policy that seems to apply to all its activities in this direction. A vigorous pioneering spirit is revealed by its incursion into new and untried fields, but this is counterbalanced by the most painstaking geophysical study, minimizing as much as possible the chances of loss through the process of proving new territory.

In the fields that Pure has discovered or where it has been an important participant it has endeavored to apply unit operation, one company being selected to operate the field while ownership is pooled in proportion to the original holdings of each party. Pure Oil has operating arrangements with Stanolind Oil and Gas Company at Graham Lake, Texas; with Phillips Petroleum Company covering the Ector, Texas, pool and the Cooper, New Mexico, development; and with Superior Oil Company in the Bosco area in Louisiana. This type of cooperative operation is recognized as highly desirable from the viewpoint of national economy since it avoids the tremendous waste that has taken place in the production of most flush oil fields in the United States. It is equally advantageous to the companies following this policy, since it reduces the cost of development and assures long life and the maximum recovery of oil.

In another direction Pure Oil has shown its practical interest in conservation by its action in repressuring wells that show a slackening in production. This system, by which it is possible to recover oil that other-



Pure Oil's well-known seal goes to sea on the "W. C. Fairbanks," 78,000 barrel ocean-going tanker of Pure Oil's extensive marine division.

wise would be lost, is being introduced in the 23-year-old Cabin Creek field where natural gas is forced into the oil sand through input wells. Not only does this force the oil through the sand to the outlet wells but it increases the fluidity of the oil in suspension. With crude of the high quality yielded by the West Virginia wells the procedure is economically feasible as well as desirable in the public interest.

Pure Oil's net production during 1937, given by states, presents an interesting picture by reason of the important part played by eastern fields in the total output. In round figures it was as follows:

State	Bbl.
Texas	8,700,000
Oklahoma	3,800,000
Louisiana	1,600,000
New Mexico	200,000
Kansas	100,000
Illinois	1,700,000
Michigan	3,700,000
Ohio	300,000
West Virginia	300,000
Total	20,400,000

By way of contrast with these figures the company's total net production in 1924 was 13,000,000 bbl.

In order to knit together its widely separated properties and to provide for their effective operation as a unified whole, Pure Oil Company faced a serious transportation problem in 1925 and this became more pressing as larger production was developed in Oklahoma and Texas. Through its purchases of various properties, the company had acquired a few short pipelines and it owned a number of tankers, but it was lacking in inland connections between its fields and refineries.

After the discovery of the Van field, the company was faced with a production of crude in that area which its one Texas refinery could not handle, while the company required additional crude for its Ohio and West Virginia refining plants. Later on, when Michigan crude became a factor in the company's production, the low octane rating of gasoline from that oil required its mixture with Mid-Continent crude to obtain the best results in refining. Most compelling of all was the consideration that cheap transportation was essential if the company was to hold its place in the highly competitive markets in which it operated.

Adopting the cooperative principle which it already had applied to production, the problem of transcontinental transportation was solved in an ingenious manner which, at the same time, provided for a better adjustment of crude supplies to refinery requirements. In 1930, an agreement was made with Standard Oil Company (New Jersey), two of its subsidiaries, and Standard Oil Company of Ohio for joint construction and ownership of the Ajax Pipe Line from Tulsa, Oklahoma, to Wood

Section of Pure's gigantic modern refinery at Smiths Bluff, Texas, readily accessible to major supply sources; close to deep water transportation and terminal facilities providing economical product landing in principal consumption centers.

Photo by Kenneth Heilbron.

Six million gallons of water are required daily for operation of Pure's Toledo refinery. Above, economical natural draft water cooling tower.

River, Illinois, there joining existing lines extending eastward with connections to the company's refineries at Newark, Ohio; Cabin Creek, West Virginia; and, later, to Toledo, Ohio.

In organizing Ajax Pipe Line the equity interest was divided on a basis that gave Pure Oil Company 25 percent. Since Pure was not in a position to fulfill its input quota requirements from Mid-Continent production at the time, it made a contract to sell a part of its Van production in Texas to Standard Oil Company of Louisiana and to take from Carter Oil Company in Oklahoma a part of its requirements for its Ohio and West Virginia refineries, thereby enabling Pure to supply its agreed quota to the pipeline. The move was advantageous for Pure Oil as it gave the company its needed connection between the Mid-Continent fields and its eastern refineries without the necessity of heavy investment. In order to provide the desired take-outs from the northern end of the line, Pure Oil supplemented its then existing markets for gasoline by a contract arrangement with the Hickok Oil Corporation, operating in parts of Ohio and Michigan, under which Pure has since acquired a half interest in its equity.

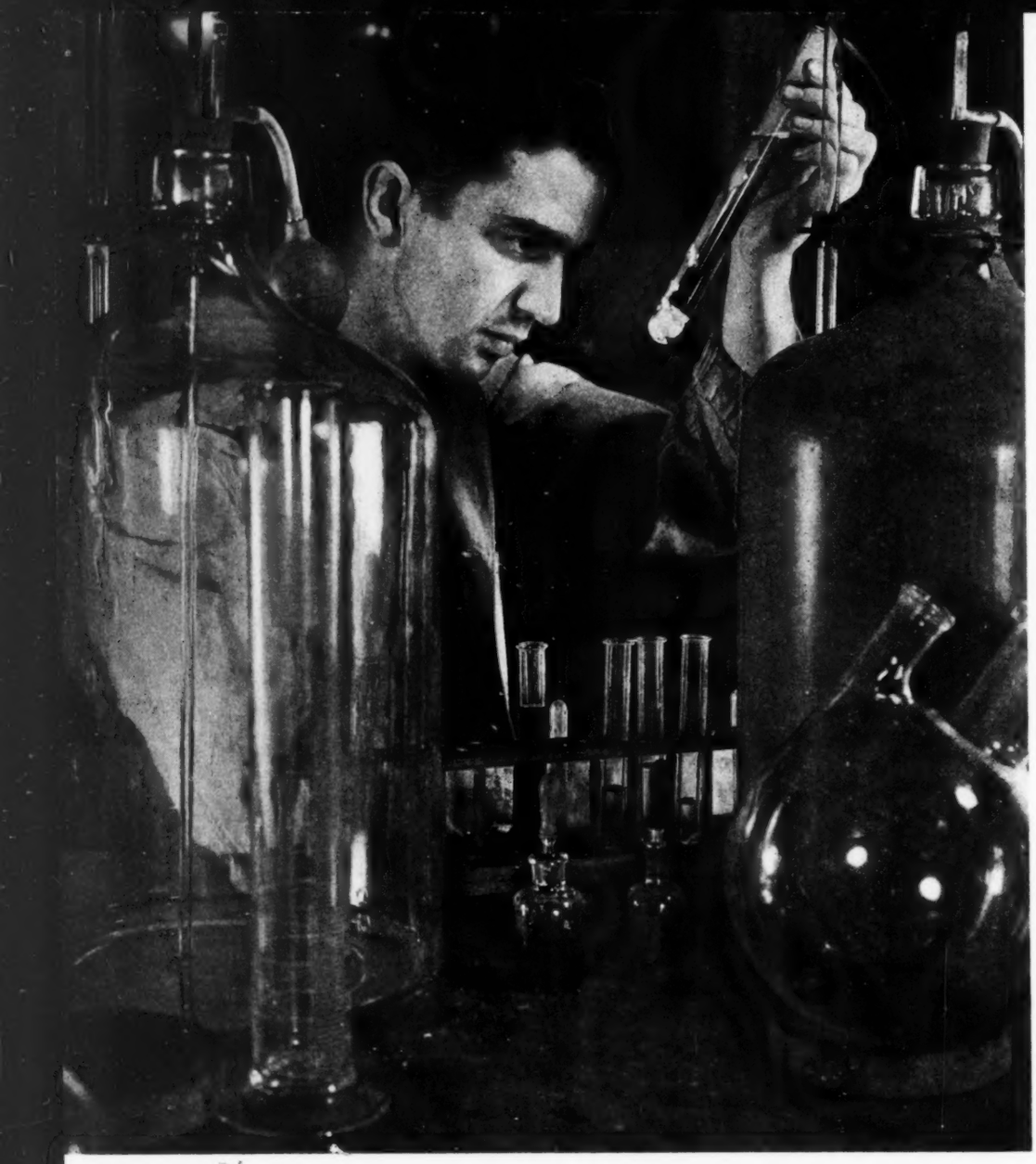
Another important step in the provision of transportation facilities was Pure's acquisition of a 10 percent interest in the Great Lakes Pipe Line, built to convey gasoline from Oklahoma northward to Kansas City, branching thence to Des Moines, Omaha, Twin Cities and Chicago. Participation in this enterprise enabled Pure to deliver supplies economically to its main distributing points in the northwestern and north central states.

To connect the Van field with tidewater, Pure previously had built a wholly-owned pipeline to Smiths Bluff. It constructed 600 mi. of gathering lines in the Oklahoma, Michigan, and Texas fields, besides a short line connecting the Bosco field with its terminal on the Mermentau River, Louisiana. Following the development of the Michigan fields, crude lines were built to the company's Midland refinery and the terminal at Bay City and a gasoline line connecting the Toledo refinery with the Hamtramck terminal at Detroit. The latter line is owned jointly with Sun Oil Company and Gulf Refining Company, with Pure Oil having a 60 percent interest.

Meanwhile, as the marketing operations of the company expanded, its marine equipment has grown proportionately. Including the Sabine Transportation Company, in which The Pure Oil Company holds a majority interest, it operates 14 seagoing tankers, 31 barges and 12 tugs. In addition, two tankers on the Great Lakes are operated by Great Lakes Transportation Company in which Pure owns a third interest. The capacity of the marine division is 1,200,000 bbl. and it enables the company to lay down its products cheaply at its numerous terminals along the Gulf and Atlantic coast. An interesting section of the fleet is composed of the shallow-draught river steamers and barges which distribute products along rivers in its marketing areas.

Through over 3,000 mi. of wholly or partly owned pipelines, supplemented by the marine equipment described, the company is equipped to move crude oil and products quickly and economically from almost any point in its widespread operating territory to any other point. Through these facilities it transported last year 75 percent of its entire output, leaving only 25 percent to be handled by outside agencies. With the expansion of its pipeline and water transport facilities the company has disposed of the tank cars it formerly operated and now leases such equipment as may be needed from time to time.

Twenty-three terminals with a storage capacity of 81,000,000 gal., nineteen of them on or adjacent to deep water, provide facilities for the economical distribution of Pure Oil products throughout the greater part of its marketing territory. Fifteen



viously acquired were the Cornplanter refinery at Warren, Pa. where the famous Tiolene lubricating oil originated, and the Cushing, Ardmore and Muskogee plants in Oklahoma. Cornplanter, Cushing and Ardmore were subsequently abandoned because of unfavorable freight rates.

The Muskogee and Marcus Hook plants were retained. Following the opening of the Michigan field, a refinery was built in 1932 at Midland, Michigan, to handle a part of the crude locally produced. In 1931, the Toledo refinery, operating on a combination of Mid-Continent and Michigan crude, was erected.

In late 1935, the company decided upon a program covering modernization, reconstruction and consolidation of refining activities at the plants located at Toledo, Smiths Bluff, Cabin Creek, Muskogee, and Heath. This program was designed to provide flexibility and economy of operation by permitting the switching to any one of a number of products which may at a particular time be more profitable than others. Completion of this program during the current year will place The Pure Oil Company definitely among the outstanding refining companies of the country.

With petroleum research making constant and varied improvements and changes necessary in refinery equipment, Pure Oil wisely withheld extensive modernization until such developments had been thoroughly worked out in actual operation. Carrying out that policy has prevented Pure Oil from being forced to frequent replacement changes of equipment developed in such years as 1932, 1933, 1934, and 1935, many of which have been subsequently outmoded.

hundred motor trucks and cars provide supplementary transportation in connection with its bulk stations and terminals.

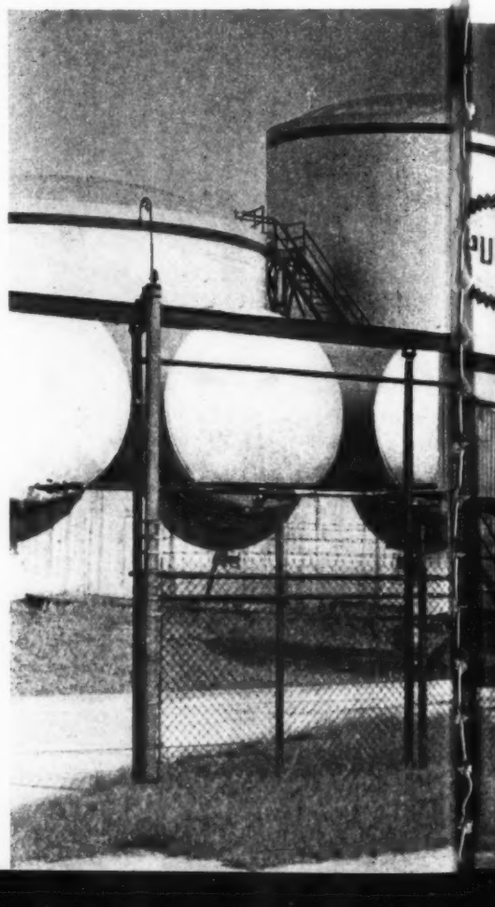
In transportation and pipeline facilities, in little more than twelve years, Pure has reached the front rank in the petroleum industry. A carefully developed and acquired system of crude pipelines, gasoline pipelines, marine equipment, inland waterway transport, and motor transportation facilities has provided Pure with effective and well balanced transportation facilities.

Above, Pure's research staff constantly seeks new methods and processes to meet requirements of today and tomorrow. Right, typical bulk-plant. Pure Oil products are distributed through 930 bulk-plants strategically located.

PERFECTING REFINERY EQUIPMENT

One of the noteworthy undertakings that has strengthened Pure Oil's position in the dozen years under review has been the relocation, reconstruction, expansion, and modernization of its refining plants and equipment. Several refineries owned by the company in its early days were acquired through purchase of various companies and because of changes in the sources of supply or high transportation costs some of these locations became economically unattractive. A few of the refineries acquired really were no more than skimming plants and were unsuited to meet rising standards in the art of refining.

The company built the Cabin Creek refinery in 1917; in 1920 it completed the Heath refinery near Newark, Ohio, with a daily capacity of 3,000 bbl., handling the entire output of Corning oil, and it was here that Cross cracking units were first installed. In 1923 the Smiths Bluff refinery was erected in Texas. Other plants pre-



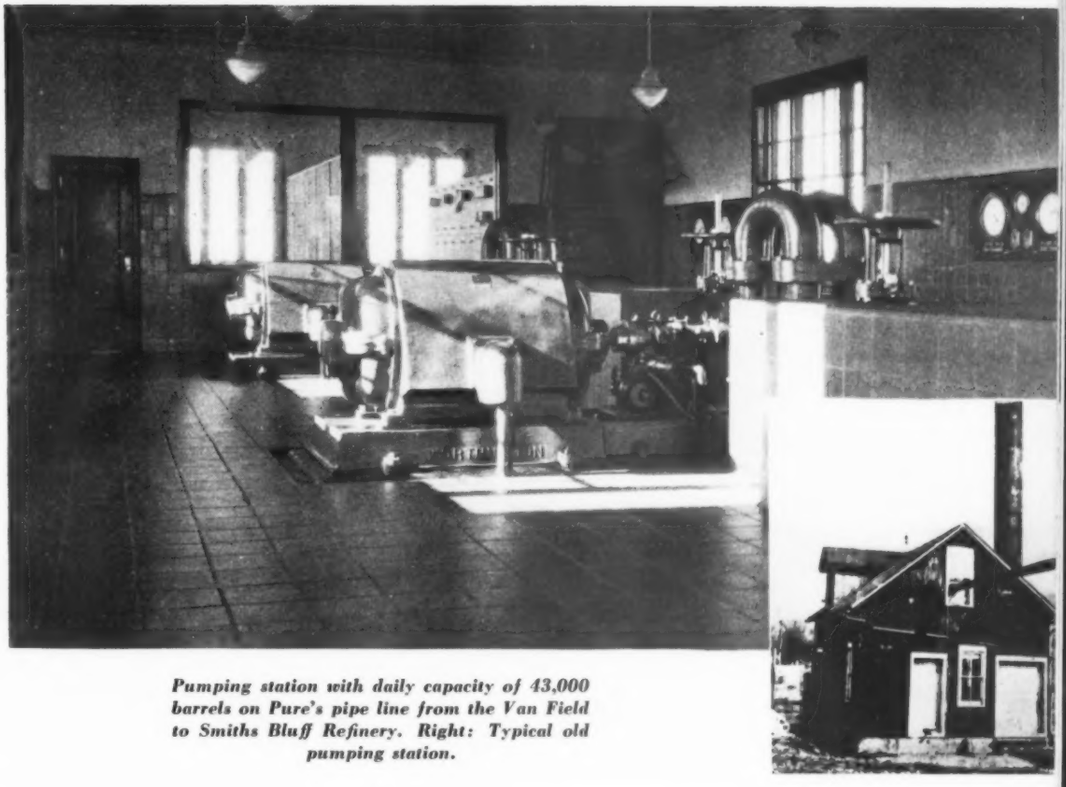
A need for equipment at Smiths Bluff which could produce a full line of gasolines, naphthas, kerosene, gas oil and residual oils, brought about the replacement of an obsolete unit by a modern tube still in 1936. A requirement for processing Cabin Creek and Pennsylvania crudes into cuts for gasoline, naphthas, kerosene, gas oil, wax distillate and cylinder stock, was filled by erecting a new tube still at Cabin Creek at the same time.

Cracking equipment at Cabin Creek was also modernized by the building of a combination cracking unit to process other crudes received there. Another unit of similar type was built at the Toledo refinery. Increased demands on Smiths Bluff, which is producing considerable quantities of products for Gulf and Seaboard markets, resulted in building a combination selective cracking unit there in 1936.

The latest equipment to go into operation was at Heath refinery, where a combination cracking unit was installed in 1937. Similar equipment of a larger size had been placed in use at Toledo just a few weeks before, completing the Toledo program, and making it one of the most modern refineries in operation. Another unit of the same kind is being prepared for use at Muskogee refinery.

Just recently, to complete the refinery modernization and replacement program, ground was broken at Smiths Bluff for a combination cracking unit which will be completed this year according to present plans. Additions to the utilities system will be made at the same time.

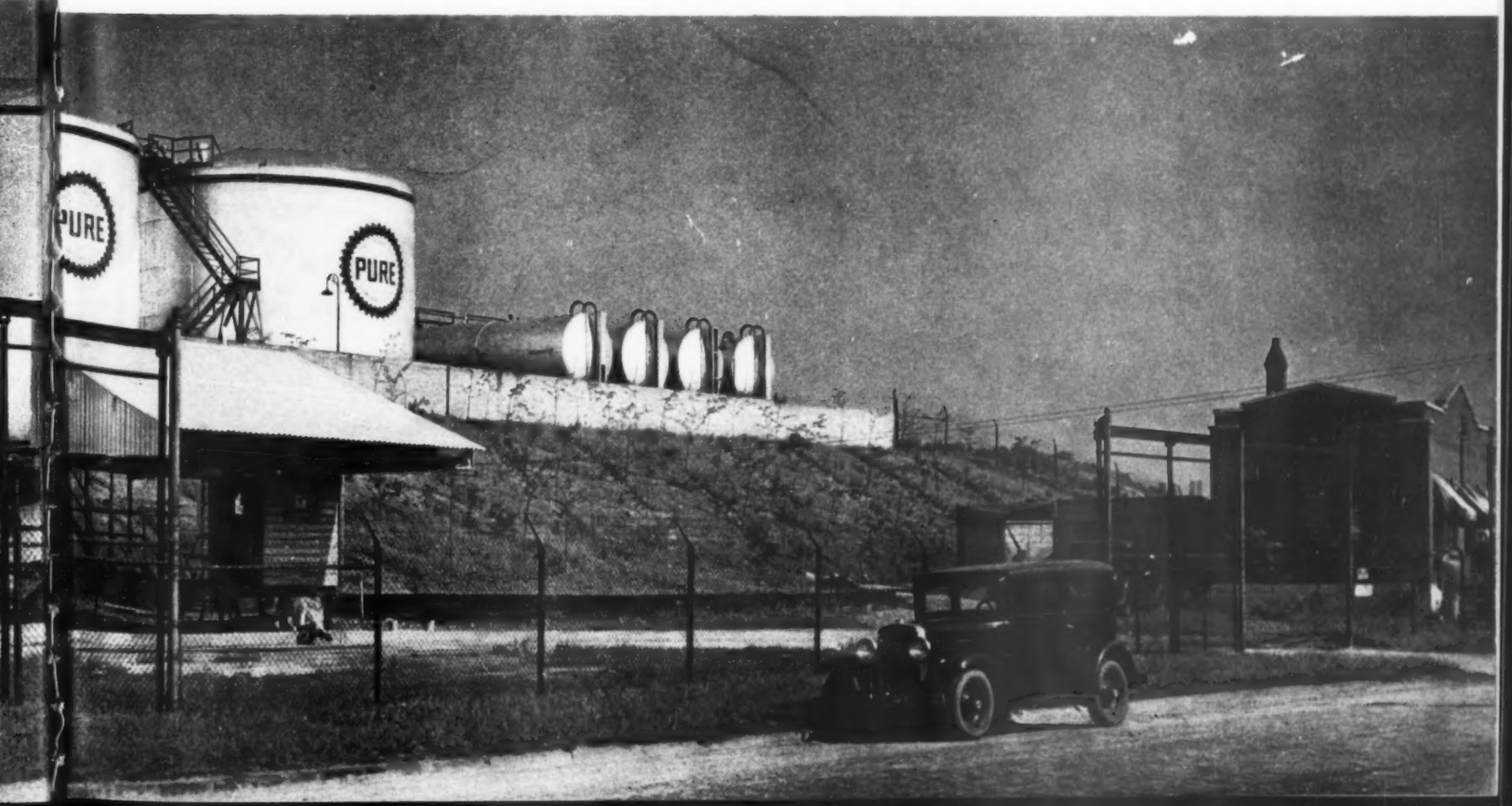
Both the Lummus Company and Alco Products Company, as engineers and contractors, have assisted in the company's modernization program. Alco installations have been at Cabin Creek and Muskogee, and Lummus contracts have been at Smiths Bluff, Heath, and Toledo.



Pumping station with daily capacity of 43,000 barrels on Pure's pipe line from the Van Field to Smiths Bluff Refinery. Right: Typical old pumping station.

Pure Oil now owns and operates seven refineries to produce the nationally known "Purol-Pep" brands of gasoline and the twin product "Woco-Pep" marketed in Southern territories. The refineries' crude capacity in February, 1938, was roundly 80,000 bbl. daily. Total storage capacity of the refineries and terminals for handling refined products is 180,000,000 gallons.

Pure Oil's gasoline is produced chiefly at Smiths Bluff, Toledo, Heath and Muskogee. The Marcus Hook refinery, now listed as a reserve base, operates as a grease plant and to manufacture soaps, paints and other products from materials used in the making of grease. Cabin Creek is engaged primarily in manufacturing lubricating oil with "Tiolene" motor oil as the leader. The Midland refinery is devoted chiefly to the extraction of solvent naphthas from Michigan crudes. Marcus Hook does not enter



the gasoline picture now, and Midland only slightly.

Under the new program, daily crude capacity will be slightly increased but gasoline capacity will substantially exceed that of the past, as the proportion that can be cracked from crude will increase because of the use of new equipment.

As a result of this reconstruction, which will cost some $12,000,000, Pure is provided with a group of efficient refineries, strategically located for economy in reaching its important markets, and with great flexibility in being able to adjust equipment in manufacturing to most profitable products.

INDIVIDUALIZED MARKETING SYSTEM

In 1929, with the tremendous discovery of the Van field and a resulting large supply of crude, and with no knowledge of the possibility of Van being prorated, Pure Oil was without adequate marketing outlets for proper integration. In developing this part of its business, Pure Oil has undergone as great a change as in its production, transportation and refining operations. Here again the company has adopted unconventional methods but has applied these with great success. Instead of launching an elaborate program of service station construction such as was carried on by many companies during the 'twenties, it has followed the plan of acquiring well-established local distributing organizations. At the same time it has retained, wherever possible, the managers who had built up the individual companies, who had a good knowledge of local conditions and enjoyed the confidence of the community. In many cases arrangements were made by which these men retained an interest in the companies they were left to operate.

Above, another field in which Pure Oil pioneered—Southern Illinois. Area surrounding the discovery well near Clay City. Right, Pure's modern transport equipment includes 5,000-gallon trailer transports. Main use: transporting products from river or pipe line terminals and refineries to bulk plants.

In this way the company, during the past several years, has acquired control of a large number of marketing organizations, many of them in the southeastern states which Pure Oil now covers very thoroughly. In a majority of cases the same procedure was followed, the marketing company retaining its former name and local identity though, of course, displaying Pure Oil emblems and selling Pure Oil products.

Many other original ideas have been contributed to the marketing of petroleum products by the Pure Oil management. One of these was the adoption of the English cottage type of structure which is associated in the minds of motorists with the Pure Oil name and is, in fact, patented by the company for its exclusive use.

Adoption of this distinctive type of structure is credited to Mr. Dawes who reasoned that a service station of pleasing appearance would attract customers and the confidence of the motoring public and that the uniformity of style would serve as a valuable advertisement for the company. It has had another helpful result by enabling Pure Oil to place its stations in residential neighborhoods where the ordinary type of station would not be permitted.

Not only are the stations themselves made attractive but operators are encouraged to keep the surrounding grounds neat and orderly. Prizes are given by the company for the best kept stations. One of the company's stations, at Evanston, Illinois, pictured on the front cover of this issue, has been often pronounced the most attractive structure of its kind in the country.

Long before the "Iowa plan" became a current phrase in the conversation of oil men and before the taxation of service station chains was attempted, Pure Oil Company began to divest itself of the operation of retail outlets and to lease or sell these to the individual operators on the sound theory that most men will work more effectively for themselves than for an employer. As a consequence of this policy, the company has very few stations under its direct management.

Pure also was one of the first companies to encourage its station men to carry lines of motor accessories, such as tires and batteries, as a means of adding to their incomes and making them more substantial business men.

Pure Oil Company's sales area now extends from Texas to New York and from

Florida to Minnesota and Wisconsin. Within this area are some 930 bulk stations which serve 17,000 retail outlets, dispensing nearly 750,000,000 gal. of products annually.

RESEARCH

Since its early days the company has been active in petroleum research. Research activities have been intensified in recent years and have resulted in notable contributions to the petroleum industry's operations. Eighty men now make up the research and laboratory staff, with 50 of the group employed in the Northfield (Illinois) laboratory where Pure's main research is conducted. An international group could readily be assembled there, for records show graduates of Cambridge, Oxford, Heidelberg, the Sorbonne, McGill, Saskatchewan, Massachusetts Institute of Technology, Dartmouth, Illinois, Marietta, Northwestern, Ohio State, Harvard, Yale, Princeton, Chicago and other colleges.

Northfield research is carried on in addition to work in plant and field laboratories. Northfield acts as a control laboratory for all plant laboratories; it issues letters describing the methods of testing all products; it checks all apparatus for accuracy, type and utility, and it is a training school for other laboratories.

It is the function of the research department to keep the company's processes at the head of the constantly improving methods used in the industry. How well this has been accomplished can be judged by the fact that the company has found itself in a basic and preferred patent position in many major developments in the industry.

Contributing to increased efficiency in plant operations, the research department is constantly developing and investigating refining procedures and formulating operating conditions which permit improvements in commercial plant operation. Information thus developed is contributing to increased yields and efficiency in many plant processes, as for example, the processing of crude oils, the manufacturing of motor oils, the sweating or refining of paraffin wax, the regeneration of clays used in the treatment of oils and the production of specialty products.

FINANCIAL

The improvement in the financial structure of The Pure Oil Company in recent years has been consistent with its development in other activities. It has been a period of increasing strength and simplifi-

Left, inland transportation, with Pure Oil's tow-boat "Wylie L. Moore" and barge en route up the Savannah River to Augusta. Below, modern Pure Oil Refinery in Toledo, Ohio, centrally located to huge consumption areas.

Cottage type, two bay, station with canopies, used in southern marketing. Pure Oil stations receive much commendation.

cation during which the Company has entirely eliminated all funded and bank debt and removed the hazard of large, maturing obligations. At the present time it has outstanding 3,982,031 shares of common stock and 725,431 shares of preferred stock.

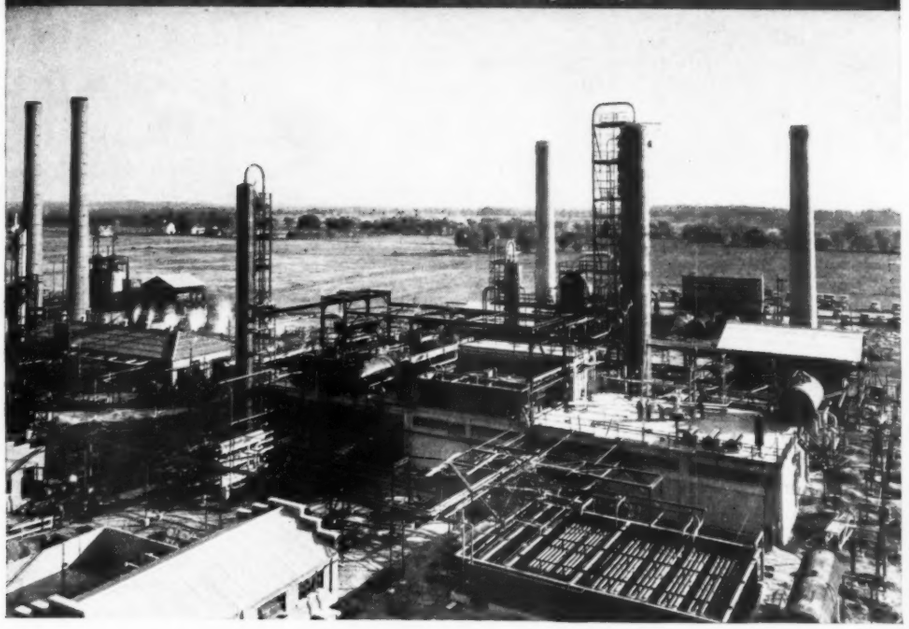
The oil industry, in service rendered and money invested, has become, in the last twenty-five years, one of the three most important in the American economic structure. Its development has gone hand in hand with that of the automotive industry, and each, in this period, has met and solved entirely new problems with spectacular success. Twenty-five years ago most people thought of the exploratory and producing phase of the oil business as a form of respectable gambling. During this period, however, every resource of modern science has been devoted to removing the uncertainties and risks which were such a tremendous and unavoidable factor in the early days. The development of pipe line transportation systems, the use of trucks, and the perfection of refining processes have contributed to bring about a condition of stability comparable to that of such older industries as steel, agriculture or the general forms of manufacture. This has inevitably entailed the use of ingenuity in adjusting financial structures to the rapidly changing conditions of an industry which has only in recent years reached this phase of its evolution.

Three bay, angular, brick cottage type station arranged for functional values. Distinctive design is a feature patented by Pure Oil Company.

Much of the romance of the oil business has been destroyed in this progress. The "coal oil johnnies," the "oil smeller," and the "witch stick" have been superseded by the PhD. and the seismograph; tin-pot skimming plants have been succeeded by complicated and efficient refineries; the curb pump has succumbed to the service station; and budgeting has taken the place of guessing.

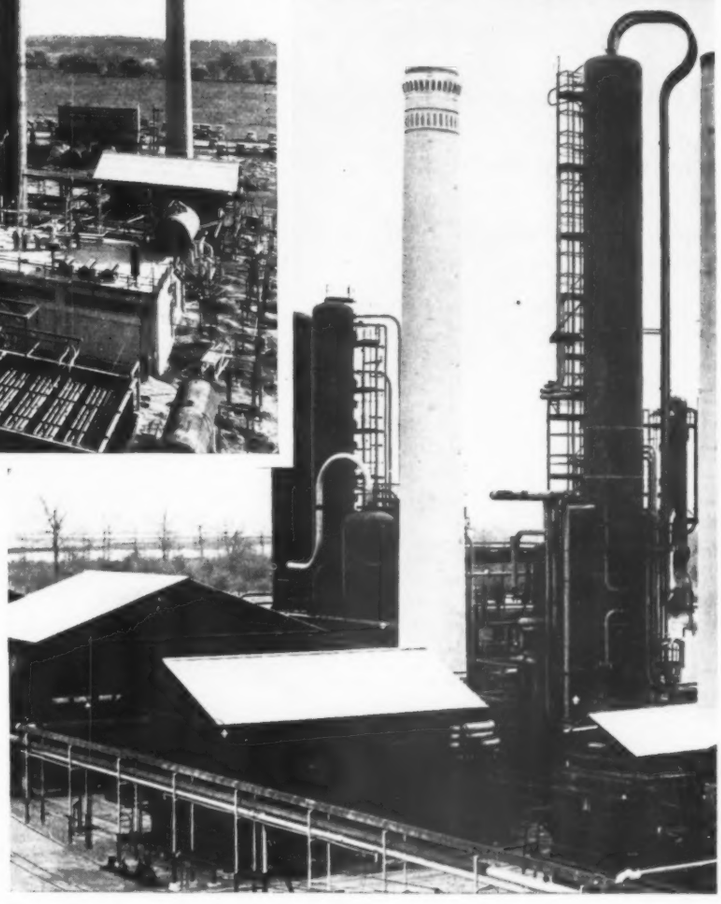
All of these changes have given an industry, once dependent for its capital upon the gambling instinct, an appeal to the conservative investor.

CRACKING . . . 6,000 bbls. per day



Lummus Combination Selective Cracking Unit, Heath. This unit is running crude from the Pure Oil Company's new Illinois field, also Mid-Continent and Corning crudes. Cracking capacity: 6,000 barrels per day.

CRUDE . . . 11,000 bbls. per day



Lummus Crude Topping Unit, Smiths Bluff; produces straight run gasoline, kerosene, special naphthas and gas oil cracking stocks. Capacity: 11,000 barrels per day.

UNDER CONSTRUCTION

Now under construction at Smiths Bluff, Lummus Combination Selective Cracking Unit with a cracking capacity of 22,000 barrels per day. One of the largest single cracking units ever built in America, this Lummus plant is designed to operate on Van Zandt, East Texas and Mixed Gulf crudes, to produce high yields of high octane number gasoline, kerosene or special naphthas, or No. 1 Furnace Oils, No. 3 Furnace Oils and fuel oil.

★

THE LUMMUS COMPANY, 420 LEXINGTON AVENUE, NEW YORK, NEW YORK

411 WEST FIFTH STREET, LOS ANGELES, CAL. • BUSH HOUSE, ALDWYCH, LONDON, W. C. 2

LUMMUS

PETROLEUM REFINING PLANTS

NAVAL-TYPE Tanker Program Initiated By Jersey Standard

Contracts for Twelve Fast 16,300-Ton Vessels Under Partial Subsidy Is Outcome of Studies by U.S. Maritime Commission—Other Oil Companies Likely to Follow Suit.

PIRACY—a threat to unarmed neutral shipping in Mediterranean and Oriental waters; civil war in Spain and Sino-Japanese incidents in the Far East, together with the vast naval expansion programs now under way, emphasize the primary need of most nations for reasonably fast merchant fleets and naval auxiliaries. Through a change in the sentiment of Congress, the United States Maritime Commission has at last been able to commence a program of subsidies to shipowners and oil companies.

The Commission has pointed out that commercial shipping is a vital part of American facilities for defense. The United States is maintaining one of the largest navies in the world—it would not be the part of wisdom to maintain such an establishment without an adequate complement of fast auxiliary vessels.

Funds aggregating $85,000,000 are held by the Commission, in addition to which Congress has authorized the expenditure of $115,000,000. This makes available a total of $200,000,000 for the purpose of rehabilitating American shipping in overseas trade.

Rear-Admiral Emory S. Land, commissioner, informs us that insofar as the question of tankers is concerned, the Maritime Commission has with the co-operation of the Navy Department determined upon minimum requirements for ships that would be suitable for naval auxiliaries. The speed requirement in this case is 16½ knots at sea when fully loaded. Negotiations have for some time been in progress with several oil companies which normally would require oil tankers of slower speed for their transportation operations. The proposal is for these companies to build faster vessels in order that they may be used as naval auxiliaries in times of emergency, the Commission to pay the difference in cost of construction.

This payment will be made outright by the Commission and the oil companies will agree to maintain these ships in operating condition for the next twenty years under the American flag. In case of such requisitioning the oil companies will be compensated for their share of the vessel, at a depreciated value.

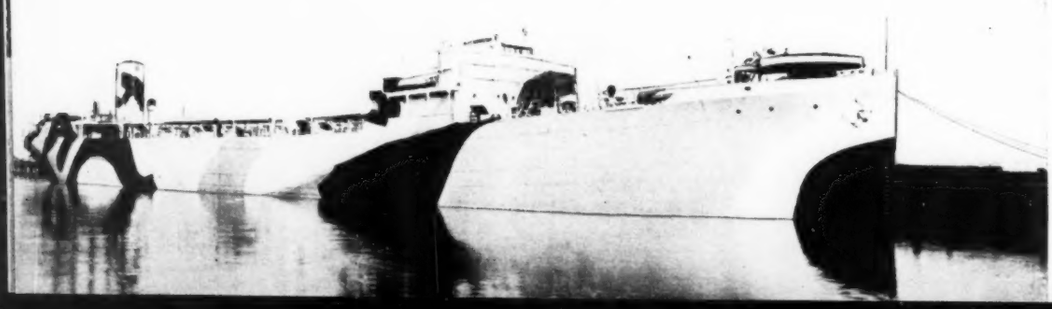
In awarding the contracts for the vessels, Jersey Standard accepted the lowest bid submitted and required other bidders to meet this price. This was $2,249,417, submitted by the Sun Shipbuilding & Dry Dock Company. The amount of differential to be paid by the Commission for the national defense features was determined in the same way, the Commission selecting the lowest differential submitted, which was $880,250. The highest differential submitted was $1,058,000, a spread of $177,250. This will make the cost of a tanker equipped with the national defense features $3,129,667.

A few weeks later, January 5th, 1938, as announced by WORLD PETROLEUM in last month's issue, the company placed contracts with the Federal, Sun, Bethlehem and Newport News shipyards, each for the construction of three 525 ft., 16,300 tons d.w., 150,000 bbl., twin-screw, geared-turbine tankers of 12,800 s.h.p. capable of 16½ knots loaded and 18 knots light. Of the total cost of $37,556,004 the government is to provide $10,563,000—at which rate it will have available a dozen tankers capable of keeping up with the fleet at only a little more than one-quarter the cost of their construction, and without the cost of maintenance, which will be absorbed by the oil company during a guaranteed period of 20 years.

Apart from high speed, the new vessels are to have a number of national defense features, including: two-compartment floodability, magazine spaces, gun foundations,

Right: America's existing Naval auxiliary oilers cannot go faster than 14½ knots—U.S.S. Brazos.

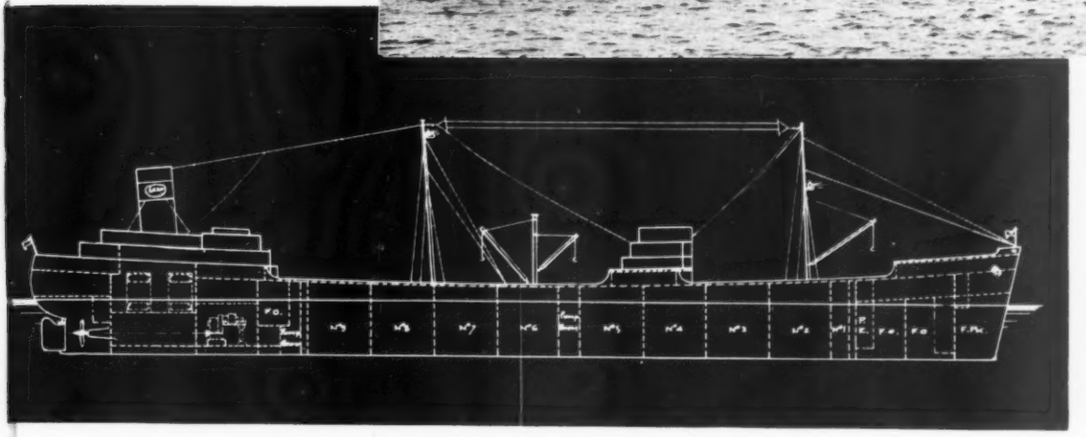
ourtesy Marine Dept., S.O.C. of New Jersey.



Courtesy U.S. Navy Recruiting Bureau.

Left: An American tanker being fitted out with gun mountings and camouflaged for protection during the World War—Ampetco.

Esso Houston—one of the latest Jersey Standard tankers—has a deadweight of 13,000 tons and averages 13 knots at sea.



Proposed general arrangement of vessels in the Esso high-speed tanker fleet just ordered. In outward appearance these vessels will probably be the same as existing Jersey Standard ships but will include a number of unusual features necessary to national defense.

oiling-at-sea gear, heavy-lift facilities (40-ton), paravane gear, Navy searchlights, extended cruising radius, and piping arrangements to allow flexible tank pumpage to carry four or more grades of oil. Construction is anticipated to take from 14 to 36 months, and to provide employment for 10,000 workers.

The Maritime Commission specified two tanker-types in its report and 20 initial orders. It is probable that eight more tankers will be contracted for in the near future by oil companies whose operating requirements do not call for such large vessels. These would be from 2,000 to 4,000 tons less in deadweight, and indications are that Diesel engines will be installed instead of steam. Altogether 34 tanker operating companies were given an opportunity to participate in this subsidized program. They could have contracted for some of the 12 larger ships had they so expressed their intention by February 1st, 1938.

Both construction and subsidization by the Maritime Commission will introduce problems beyond those of design, and it is perhaps the actual operation of these vessels which possibly caused the oil companies some misgivings.

The government is providing payment of the construction cost differentials, but the private interests evidently must themselves absorb the operating differentials—for these vessels undoubtedly will be designed to run with maximum efficiency at high speeds. Although it is not definite, it appears to be the intention of Jersey Standard to operate the vessels in commercial traffic with speeds reduced to the normal rate of other vessels flying the American flag—in which case their economics will probably be poor. They are to be run in U.S. coastwise service.

Inasmuch as the government will be making reservations to the effect that such tankers shall be immediately available for use in fueling U. S. Naval fleets in event of emergency, there are a number of other aspects which may cause inconvenience. While the oil companies are willing to cooperate as much as is within their power, they are active in a highly-competitive business and it would be indeed detrimental to their trade should the government decide that a state of national emergency had arisen when the vessels were engaged on voyages fulfilling important oil shipment contracts. However, this liability applies to any tanker, regardless whether or not built to meet naval requirements. Washington has the authority to commandeer any ship in the event of war. In any event it is extremely unlikely that the Navy Department will be unreasonable.

There are also other questions. Will the tanker operators be required to replace their own officers and crews with naval reserves?, or will it be required that a certain percentage be naval reserves? Although such a ruling would necessitate the oil companies making place for some of their existing staff elsewhere, or dispensing with their services entirely, it would possibly have the unique advantage of preventing some of the unreasonable strikes which have occurred in the American merchant marine.

Regarding the Martime Commission's intention to build oil tankers for its own account, states Rear-Admiral Land, this part of the program has not as yet crystallized to the extent of a definite decision, although tentative designs of oil tankers have been laid out and discussed.

As the aggregate contract price of these 12 tankers is $37,566,004, of which the Standard Oil Co. (New Jersey) is providing $27,063,004, this important order forms another striking instance of the splendid manner in which oil companies provide employment during times of business recession. It should not be forgotten that the Jersey Standard has under construction in American yards four other large tankers which form part of a program of 10 vessels each of 13,000 tons d.w. and 12¾-13 knots speed ordered about 18 months ago. This fleet has a total contract price of $13,000,000.

In fact, a large proportion of the ship construction during 1937 has been tankers. On the ways, or on order, on January 1st, 1938, there were also 15 oil-carrying vessels for other American petroleum companies—Gulf Oil Corporation; Standard Oil Company of Indiana; Pan-American Petroleum & Transport Company; Socony-Vacuum Oil Company; Tidewater Oil Company; The Texas Corporation; Atlantic Refining Company; Sun Oil Company; and the Bermuth Lemboke Company. These particular vessels range from 5,000 tons (gross) to 11,400 tons (gross) with the exception of one coastwise tanker of 1,730 tons (gross). This means that the oil industry has recently provided about $75,000,000 in business to the domestic shipyards and engineering plants, apart from being of great value to the steel industry. Orders for further tankers are likely to follow shortly.

California Goes "

Two 4-Cylinder 400 H.P. CLARK "Super-2-Angles", New Wilmington Gasoline Plant, General Petroleum Corporation

Photo Courtesy of "Sunkist"

"2-Cycle-Angle"!

General Petroleum Installs CLARKS in Latest Plant at Wilmington

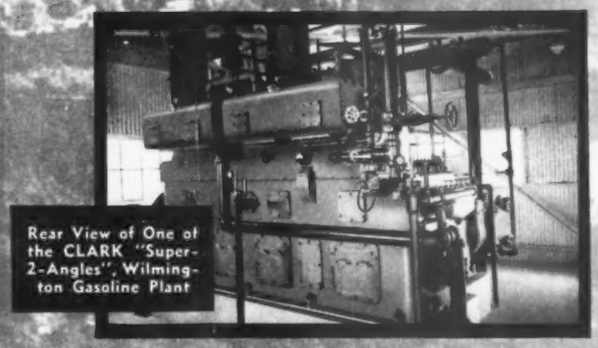
GENERAL PETROLEUM originally selected the two CLARK 4-cylinder, 400 H.P. 2-cycle-angle compressors shown on the opposite page; and subsequently ordered two more of these units for the extension of their new natural gasoline plant at Wilmington.

The CLARK "Super-2-Angle" is chalking up new records for economical installation and economical operation. These units are enjoying a sensational national success because they are equal to horizontal compressors in power and efficiency, yet accomplish 5 substantial savings, viz: (1) Shipped assembled, they cut transportation and erection costs; (2) They require much smaller foundations; (3) Require less floor space, smaller buildings; (4) They save fuel, due to CLARK Super-2-Cycle Fuel Injection; (5) They save on maintenance, due to extreme mechanical simplicity.

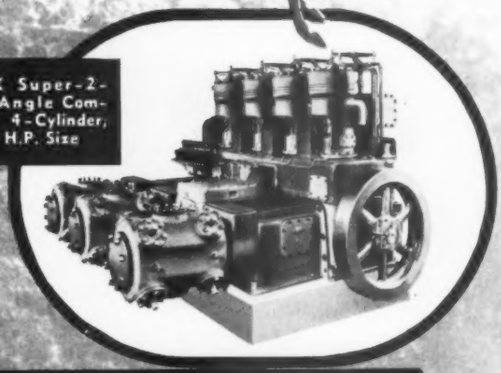
The 4-cylinder 400 H.P. size is the most economical size that can be installed, giving lowest dollar cost per 1,000 cubic feet of gas delivered. In economy this unit is not only superior to any other size, but to any other unit on the market.

We will gladly furnish the complete engineering facts and figures on the CLARK "Super-2-Angle", furnished in 2, 3, 4 and 6-Cylinder sizes, ranging from 200 to 600 H.P.

CLARK BROS. COMPANY, Olean, New York, U.S.A.
Export Office: 30 Rockefeller Plaza, New York. Midcontinent Sales Offices and Warehouses: Tulsa, Okla., Houston and Dallas, Texas. West Coast Office: Smith-Booth-Usher, 2001 Santa Fe Av., Los Angeles. Foreign Offices: 72 Turnmill St., E. C. 1, London, England; 4 Str., General Poetas, Bucharest, Roumania



Rear View of One of the CLARK "Super-2-Angles", Wilmington Gasoline Plant



CLARK Super-2-Cycle Angle Compressor, 4-Cylinder, 400 H.P. Size

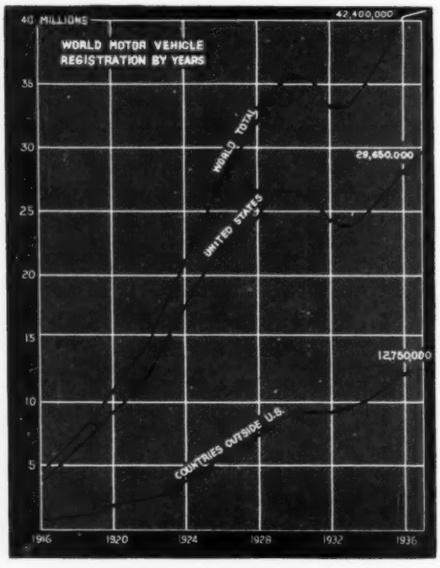
CLARK

AUTOMOBILE Registration Forecasts Increased Gasoline Demand Abroad

THE TREND of automotive registrations in the United States, and more particularly abroad, the progress in road construction in the less highly developed areas of Europe, Asia and South America, furnish an exceptionally reliable index of the future demand for petroleum products.

Preliminary figures for 1937 are now available and indicate that the rate of increase in automobile registration is maintaining its upward trend following the temporaty setback apparent in the period between 1930 and 1933. The accompanying chart indicates the trend in automotive registrations from 1916 to the present for the world, for the United States and for countries outside the United States. The chart is based upon figures published in AUTOMOTIVE FACTS AND FIGURES. It indicates that while registrations outside the United States increased from 719,246 in 1916 to 9,277,044 in 1931, up some 1,189 percent in the 16 years, they suffered a decline of only two percent in 1932 and again increased by 2.8 percent in 1933. Each year since then has shown a marked increase in registrations outside the United States over the preceding year. In 1937 this class of registrations increased by 5.6 percent over 1936 and reached a figure of 12,750,000.

The situation in the United States has been roughly parallel but marked by greater fluctuations and carrying far more weight as this country accounts for roughly three-fourths of the world's motor vehicles. Thus between 1916 and 1930 (the pre-depression peak in the U. S.) total registrations increased from 3,512,996 to 26,545,281, a gain of not less than 655 percent. But the decline in registration in the United States continued for three years rather than for only one year. Between 1930 and 1933 registration declined by 6.5 percent. They resumed their upward trend in 1934 with an increase of 4.6 percent over the preceding year. In 1935 they again increased 5.2 percent. In 1936 U. S. registrations had exceeded the pre-depression peak by a substantial number. In 1937 they ran 5.06 percent above 1936 and reached the all-time peak of 29,650,000.



Explanation of the larger percentage increases in countries outside the United States is to be found in the smaller number of automobiles abroad at the beginning of the period. Moreover, increases in registration will continue at a more rapid rate abroad than in this country.

In support of this view it is only necessary to point out that the United States already has one vehicle to every 4.5 persons in 1937 while Europe has but one vehicle for 65 persons, Asia has one vehicle to 1,687 persons and South America has one vehicle per 159 persons. Another evidence of the more rapid increase in registrations outside the United States is to be found in the fact that in 1916 this country possessed 83 percent of the world's motor vehicles; this percentage has followed an almost yearly decrease until today the United States has only 69 percent of the registered automobiles in the world.

All this would seem to indicate that the oil industry may expect to find a more rapidly increasing demand, at least for gasoline, in some of the less mechanized areas of the world than in the United States; and this increase in demand abroad is sufficiently more rapid than in the United States to justify one in concluding that, if the present trend continues, the rest of the world will have a gasoline demand equal to that of the United States by sometime in 1953.

Figures for the past five years indicate the location of greatest advance in the use of motor vehicles. In 1932 the total number of vehicles in the world was 35,055,000 or about one vehicle for each 59 persons in the world. By 1937 automobile registrations for the world had increased to 40,258,000, or one vehicle for each 51 persons. The United Kingdom, North America, and Australia and New Zeland were the only major geographical divisions showing greater than average concentration of vehicles in relation to population. The United Kindom with 2,241,000 registrations in 1937 had one car to each 20 persons; North America with 29,630,000 cars had 5.4 persons per vehicle; Australia and New Zeland had but 16 persons per vehicle with a total registration of 907,000.

Russia showed a tremendous improvement in number of automobiles in relation to population during the five years, 1932-1937. At the beginning of the period, with only 61,000 motor vehicles, Russia had 2,405 persons per motor car, the poorest concentration of any major geographical division except China (10,595 persons per vehicle). By the end of the period Russia had 356,000 motor cars, or one to every 479 persons. This fact helps in large measure to explain Russia's decreasing importance as an oil exporting country.

Asia, if not China, should offer an exceptional field for automotive development in the future. This condition, with its attendant increase in demand for petroleum products, is likely, however, to be delayed for some time. A more fertile field for motorization is to be found in South America which has but 672,000 registrations or 159 persons per vehicle compared with Europe's 65 persons per vehicle. South America has only 1.4 automobiles per mile of road, while Europe already has 2.1 vehicles per mile of road. With greater road mileage per car and a standard of living at least comparable, if not superior, to that of Europe a considerable development in motorization should occur in the near future in South America.

In Africa in 1932 there were 320,000 automobiles or one to every 314 persons; in 1937 with 441,000 automobiles the concentration had been increased to one car per 228 persons.

In conclusion, it is apparent that Russia, Asia, Africa and South America, because of low ratio of automobiles to population, offer the greatest areas for expansion in demand for oil products. However, Russia, because of her program of national self-sufficiency, and Asia, because of the profound social and economic changes that would be necessary, may be eliminated from consideration for the immediate future. On the other hand, Africa, some parts of Europe and more particularly South America may see an automotive development in the near future that will have a very appreciable effect on the flow of oil in international trade.

OIL OUTPUT RISES 13.40 Percent in 1937

World Petroleum Production of 2,039,074,221 Bbl. for Year Features Increase in Proportion by the Two America's and the Near and Middle East.

DURING 1937 the world produced a grand total of 2,039,074,221 bbl., as against 1,797,993,578 bbl. in the previous year, or an increase in daily average from 4,912,634 bbl. to 5,586,595 bbl., representing a rise of 13.40 percent over the 1936 figure.

Sources of the 13.40 percent increase in world production were the America's and the Near and Middle East, while Europe and the Far East are losing place in proportion to the world total. In 1937 Europe declined in relative importance by 2.20 percent to 12.86 percent of the world's output; likewise the Far East declined by 0.42 percent to 3.12 percent. The greatest growth in relative importance during the year under review was by North America, which increased to the extent of 1.61 percent of the total (this was mainly through the rise of the United States); the Near and Middle East rose in the case of nearly all the producing countries increasing in relative proportion by 0.34 to 5.84; South America increased by 0.32 percent to 12.68 percent.

Greatest increase in percentage of world petroleum output was by the United States, which increased by 1.51 percent to 62.61 of the world total (1,277,824,000 bbl.); greatest percentage decline was in the case of Russia by 1.18 percent to 9.2 percent, although the barrelage figure rose. This decline on the part of Russia resulted in a closer approach of the Venezuelan output to Russia's and, at the present rate of increase for the former country, it is quite likely that 1938 will see Venezuela once more taking the position of second largest producer of the world. Venezuela's proportion of the world's total in 1937 was 9.17 percent as against 8.64 percent in 1936.

In tables on the following pages, conversions from long tons, metric tons, and other weights and measures to barrels, and from barrels, etc., to metric tons, are based on the weighted average specific gravities of the principal producing fields in individual countries.

Adoption of these factors, replacing the former method of calculating barrels at the ratio of seven to the ton, is due to their great desirability in view of the fairly wide difference between specific gravities in different parts of the world, or even within the limits of a single producing area, resulting in a somewhat erroneous impression of the relative importance of various countries. Mention might be made here of the excellent work of K. Dijk, of Royal Dutch-Shell in urging the standardization and correlation of production figures compiled by various sources.

Iran, which held fifth place in 1936 rose to fourth place in 1937 with a total of 78,740,500 bbl. while Netherlands India also rose in importance and took fifth place. Roumania suffered a severe decline both in actual production and in relative importance to the world's total and now holds sixth place. Mexico has increased both in production and in relation to the world's total—an even greater increase was prevented by the oilfield disturbances from May through September, during which period production was greatly curtailed. Iraq, on the other hand, while increasing its output somewhat over that of 1936, suffered a decline in relative importance. The country has vast resources, but production is limited by the capacity of the pipeline leading to tidewater. It is understood that the output comes from a relatively few wells in Kirkuk, while other strong flowing wells there and at Mosul are shut-down pending the erection of a second pipeline to the Mediterranean.

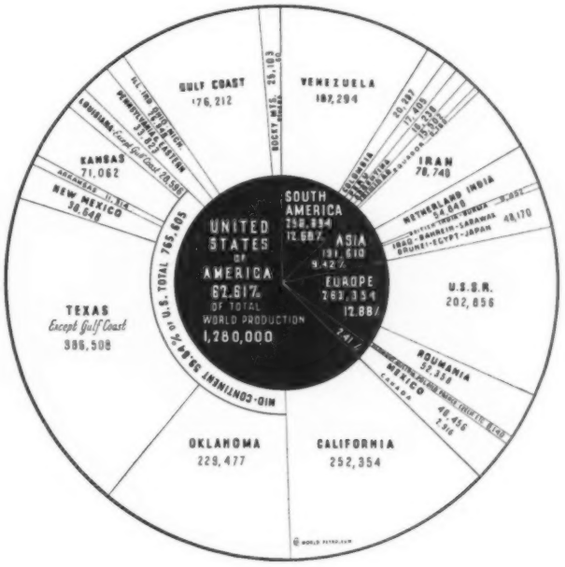
Colombia, although down slightly in proportion to the world's total during 1937, rose in barrelage. Here, also, is a country which a few years from now will be of even greater importance, in this case due to the anticipated development of the Barco area.

Production of Peru suffered a slight decline in 1937 from 17,593,069 bbl. to 17,405,335 bbl. Argentine increased its output from 15,457,960 bbl. to 16,235,910 bbl. In the case of these two countries an interesting point is raised. Peru, although declining, shows a higher barrelage figure than Argentine; whereas, in the corresponding table in metric tons, Argentine produced about 2,339,000 metric tons as against 2,307,000 metric tons by Peru.

Trinidad continues its steady growth and may be expected to expand even further as its oilfields are extended.

Burma increased its crude oil output appreciably during 1937, while Bahrein increased its production to a point where its percentage of the world's total is, to the second decimal, the same as that of Burma, i.e., 0.38 percent. Reserves were further augmented during 1937 by discovery of high-gravity crude at deeper levels.

Poland declined in output despite government encouragement of drilling while Brunei increased, replacing the former country in fifteenth place. Canada more than doubled its production thus rising from twenty-second place to eighteenth place, due to the Turner Valley extension. Austria quadrupled its output and replaced Czechoslovakia in twenty-fifth position.



WORLD OIL PRODUCTION IN 1937

Relative importance of the principle petroleum producing areas of the world in proportion to the total, based on preliminary figures received by this journal. Subsequent receipt of details has, in some instances, effected slight differences between the following tables and the chart on this page. These are not enough to change the relative positions.

WORLD OIL PRODUCTION—U. S. Barrels

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified—Table revised monthly

(Figures in U.S. barrels of 42 gal.—Conversion ratios used are weighted averages for individual countries)

	January (Bbl.)	February (Bbl.)	March (Bbl.)	April (Bbl.)	May (Bbl.)	June (Bbl.)	July (Bbl.)	August (Bbl.)	September (Bbl.)	October (Bbl.)	November (Bbl.)	Preliminary Figures December (Bbl.)
United States	98,567,000	93,173,000	106,724,000	104,979,000	110,911,000	105,812,000	110,721,000	115,090,000	109,980,000	110,911,000	104,206,000	106,750,000
Russia[2]	16,117,461	13,796,325	15,907,051	15,401,771	18,130,230	17,953,812	18,580,752	17,183,259	16,663,000[1]	17,600,000[1]	16,923,000[1]	17,600,000
Venezuela	9,559,159	13,130,903	15,066,287	14,686,657	14,498,968	16,260,492	16,469,071	17,861,784	17,640,872	17,979,227	17,044,016	17,096,298
Iran[3]	5,761,500	4,847,342	6,443,516	6,329,968	6,293,460	6,752,478	7,207,398	7,313,264	7,130,570	7,074,122	7,821,616	6,637,248
Netherland India	4,277,099	4,011,266	4,415,436	4,348,185	4,553,298	4,464,725	4,708,460	4,672,953	4,586,638	4,766,689	4,626,395	4,671,582
Roumania	4,768,000	4,217,000	4,595,000	4,412,000	4,494,000	4,151,000	4,317,000	4,293,000	4,256,000	4,313,000	4,162,000	4,198,000
Mexico	4,233,635	3,922,929	4,307,952	4,249,838	3,387,950	3,338,311	3,848,587	2,800,868	3,432,101	4,372,808	4,211,293	4,350,000
Iraq	2,638,745	2,386,687	2,709,260	2,665,259	2,747,102	2,344,213	2,429,587	2,429,787	2,513,145	2,663,244	2,645,099	2,431,532
Colombia	1,668,490	1,617,441	1,622,226	1,660,469	1,678,580	1,724,173	1,681,799	1,592,592	1,617,433	1,811,759	1,797,625	1,824,956
Peru[4]	1,462,871	1,335,130	1,479,964	1,426,891	1,451,220	1,427,939	1,484,382	1,489,513	1,448,464	1,484,761	1,428,079	1,486,121
Argentina	1,355,029	1,237,459	1,394,757	1,361,540	1,381,485	1,339,940	1,355,420	1,345,513	1,369,767	1,360,000[1]	1,365,000[1]	1,370,000
Trinidad	1,263,456	1,157,408	1,287,097	1,301,260	1,351,198	928,752	1,377,547	1,433,474	1,358,600	1,393,317	1,300,485	1,349,908
Burma[5]	583,428	601,638	635,792	625,937	690,501	638,874	633,401	679,335	701,066	660,000[1]	653,000[1]	690,000
Bahrein[6]	730,064	549,260	799,994	659,557	432,748	684,348	585,917	254,937	662,861	847,988	749,354	805,236
Brunei[7]	386,181	356,897	389,612	363,226	376,191	349,500	353,313	373,760	341,111	351,711	376,487	405,623
Poland	319,876	295,620	316,844	318,360	318,360	310,780	318,360	318,360	310,780	325,940	318,360	325,940
Germany	263,369	231,466	243,012	247,060	245,088	249,434	267,847	279,727	282,155	288,926	272,665	277,551
Canada[8]	141,078	153,906	175,575	188,014	192,845	209,181	241,737	288,934	298,753	342,452	341,517	408,580
Japan[9]	219,410	194,037	207,423	198,898	206,544	200,092	204,710	214,819	205,914	210,228	214,330	211,000
Ecuador	180,058	160,675	180,727	181,352	189,658	182,711	186,175	184,780	178,122	182,053	176,252	178,776
British India[10]	174,507	155,219	167,418	162,699	172,458	181,436	168,467	168,034	159,226	200,000[1]	180,000[1]	170,000
Sarawak[11]	136,658	124,609	136,887	130,481	134,523	131,625	143,445	138,031	134,311	133,684	126,439	131,901
Egypt[12]	99,518	86,780	93,432	89,480	97,077	98,021	99,182	97,818	100,699	97,203	95,082	94,509
France	37,148	39,990	43,053	41,865	42,096	45,445	42,125	43,367	44,000[1]	41,000[1]	42,000[1]	43,000
Austria*	20,237	18,277	20,237	19,586	21,259	20,573	21,252	17,108	16,555	17,101	18,000	20,000
Czechoslovakia	9,311	9,595	9,383	9,574	8,824	10,824	11,529	10,125	9,667	10,865	12,297	11,000
Others[1]	29,200	26,400	29,200	28,300	29,200	28,300	29,200	29,200	28,300	29,200	28,300	29,200
Totals	155,002,588	147,837,259	169,401,135	166,087,227	174,035,863	169,838,979	177,487,663	180,604,342	175,470,110	179,468,278	171,134,691	173,567,961

*Based on quarterly returns.

[1] Estimate.
[2] Russian Sakhalin included with Russia.
[3] Anglo-Iranian Oil Company Ltd. figures revised—fuel oil returned to ground has been deducted.
[4] International Petroleum Company and Lobitos Oilfields Ltd. figures combined.
[5] Do not include Assam and Punjab, which are listed separatedly under British India.
[6] Bahrein Petroleum Company Ltd. figures.
[7] British Malayan Petroleum Company Ltd. figures.
[8] Includes natural gasoline production.
[9] Japanese Sakhalin, Taiwan (Formosa) and Hokkaido included with Japan.
[10] Excluding Burma.
[11] Sarawak Oilfields Ltd. figures.
[12] Anglo-Egyptian Oilfields Ltd. figures.

WORLD TOTAL FOR 1937, BARRELS = 2,039,074,221

Official Crude Oil Production Figures for 1932 to 1937

	Daily Average 1937 (Bbl.)	Daily Average 1936 (Bbl.)	Preliminary Total 1937 (Bbl.)	Total 1936 (Bbl.)	Total 1935 (Bbl.)	Total 1934 (Bbl.)	Total 1933 (Bbl.)	Total 1932 (Bbl.)
United States	3,500,887	3,001,410	1,277,824,000	1,098,516,000	996,596,000	908,065,000	905,656,000	785,159,000
Russia	553,305	545,453	201,856,661	199,635,921	184,008,033	175,635,783	155,596,429	155,927,997
Venezuela	513,133	424,237	187,293,734	155,270,840	148,809,057	136,098,681	117,113,940	115,615,782
Iran*	215,727	172,080	78,740,500	62,981,377	57,522,398	57,905,242	54,443,038	49,519,393
Netherland India	148,255	131,043	54,112,933	47,961,744	45,307,913	45,107,828	41,234,498	37,988,913
Roumania	142,948	173,587	52,176,000	63,532,846	61,270,072	61,849,306	53,919,708	53,651,978
Mexico	127,277	112,098	46,456,272	41,027,915	40,240,563	38,171,946	34,000,830	32,805,496
Iraq	83,846	81,730	30,603,660	29,913,150	27,410,983	7,639,849	1,094,915	871,840
Colombia	55,609	51,246	20,297,543	18,756,110	17,597,655	17,337,900	13,156,126	16,415,214
Peru	47,686	48,068	17,405,335	17,593,069	17,056,555	16,314,381	13,257,318	9,899,265
Argentina	44,482	42,235	16,235,910	15,457,960	14,297,025	14,021,901	13,690,556	13,138,747
Trinidad	42,472	36,167	15,502,502	13,237,030	11,671,224	10,894,363	9,561,353	10,126,121
Burma	21,351	20,731	7,792,972	7,587,718	7,181,113	7,278,859	7,114,311	7,073,437
Bahrein	21,266	12,690	7,762,264	4,644,635	1,264,807	285,072	31,377	902
Brunei	12,120	9,009	4,423,612	3,296,938	3,302,905	2,705,350	2,035,656	1,200,026
Poland	10,404	10,572	3,797,580	3,869,575	3,901,881	4,011,336	4,174,079	4,219,634
Germany	8,625	8,389	3,148,300	3,076,858	2,967,438	2,204,402	1,656,602	1,594,807
Canada	7,992	4,110	2,982,572	1,504,287	1,447,204	1,410,895	1,145,333	1,044,412
Japan	6,815	6,568	2,487,405	2,403,072	2,294,878	1,872,837	1,504,412	1,683,439
Ecuador	5,922	5,308	2,161,339	1,942,467	1,731,785	1,636,619	1,619,902	1,597,641
British India	5,640	5,405	2,059,464	1,978,329	2,037,810	1,921,863	1,628,803	1,743,878
Sarawak	4,391	4,229	1,602,594	1,547,882	1,776,593	1,942,591	2,206,815	2,329,733
Egypt	3,147	3,392	1,148,801	1,241,550	1,234,170	1,501,624	1,625,895	1,854,057
France	1,384	1,562	505,089	534,063	529,664	700,000	786,366	755,146
Austria	631	143	230,185	52,339	46,312	29,246	5,992	840
Czechoslovakia	337	346	122,994	126,603	136,580	177,797	121,695	126,603
Other countries	942	826	344,000	303,300	352,500	401,000	385,500	369,800
Total	5,586,595	4,912,634	2,039,074,221	1,797,993,578	1,651,993,118	1,517,121,671	1,438,767,449	1,306,714,101

*Conversion factor revised, February, 1938

WORLD OIL PRODUCTION — Metric Tons

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified—Table revised monthly

(Figures in Metric Tons.—Conversion ratios used are weighted averages for individual countries)

	January (M. Tons)	February (M. Tons)	March (M. Tons)	April (M. Tons)	May (M. Tons)	June (M. Tons)	July (M. Tons)	August (M. Tons)	September (M. Tons)	October (M. Tons)	November (M. Tons)	Preliminary December (M. Tons)
United States	13,343,307	12,613,104	14,461,080	14,211,317	15,014,459	14,324,083	14,988,629	15,580,073	14,888,317	15,014,349	14,106,674	14,451,060
Russia[2]	2,210,900	1,892,500	2,181,900	2,249,900	2,487,000	2,462,800	2,548,800	2,357,100	2,290,000[1]	2,410,000[1]	2,320,000[1]	2,410,000
Venezuela	1,412,614	1,940,432	2,226,286	2,170,332	2,290,375	2,402,910	2,433,733	2,557,453	2,606,899	2,630,106	2,518,696	2,526,422
Iran[3]	762,750	641,727	842,246	837,908	841,059	893,943	952,943	968,184	942,929	936,657	903,318	878,688
Netherland India	572,765	538,425	592,676	583,649	611,181	599,292	632,008	627,242	615,655	639,824	620,994	627,058
Roumania	653,151	576,315	577,672	604,384	615,616	568,630	591,369	588,082	583,014	590,822	570,137	575,068
Mexico	628,088	582,387	639,541	630,910	509,617	495,592	571,491	415,806	509,516	649,110	625,192	646,000
Iraq	353,814	320,017	363,269	357,396	368,343	314,322	345,443	325,796	336,973	357,099	354,666	326,030
Colombia	232,542	225,426	226,094	231,424	233,948	254,240	234,395	221,964	225,425	253,904	250,540	254,349
Peru[4]	193,860	176,948	196,125	189,225	192,184	189,230	196,711	197,391	191,950	196,761	189,250	196,942
Argentina	193,051	190,216	210,851	193,979	196,821	190,902	193,107	191,697	195,151	194,000[1]	194,000[1]	195,000
Trinidad	177,801	162,878	181,128	183,121	190,149	130,699	193,857	201,727	191,190	196,076	183,012	189,967
Burma[5]	80,551	83,065	87,794	86,419	95,333	88,344	87,450	93,792	96,930	91,100[1]	90,200[1]	95,300
Bahrein[6]	99,899	75,159	109,468	90,251	59,216	93,644	80,175	34,885	90,703	116,036	102,539	110,186
Brunei[7]	50,640	46,800	51,090	47,630	49,330	45,830	46,330	47,700	44,730	46,120	49,500	53,110
Poland	42,200	39,000	41,800	42,000	42,000	41,000	42,000	42,000	41,000	43,000	42,000	43,000
Germany	37,933	33,338	35,001	35,584	35,300	35,926	38,578	40,289	40,639	41,614	39,272	39,977
Canada[8]	17,822	19,442	22,179	23,739	24,361	26,349	30,538	36,500	37,740	43,262	43,143	51,614
Japan[9]	31,224	28,467	29,518	28,305	29,393	28,473	29,132	30,570	29,303	29,917	30,502	30,000
Ecuador	24,101	22,771	25,613	25,702	26,871	25,894	26,385	26,188	25,244	25,801	24,965	25,377
British India[10]	24,093	21,430	23,114	22,463	23,809	25,050	23,273	23,199	21,983	27,600[1]	24,800[1]	23,400
Sarawak[11]	17,920	16,340	17,950	17,110	17,640	17,260	18,810	18,100	17,350	17,530	16,580	17,270
Egypt[12]	14,227	12,406	13,357	12,792	13,878	14,013	14,179	13,984	13,681	13,530	13,593	13,511
France	5,202	5,600	6,029	5,862	5,895	6,322	5,899	6,073	6,200	5,900[1]	6,000[1]	6,100
Austria*	2,891	2,611	2,891	2,798	3,037	2,939	3,036	2,444	2,365	2,443	2,570	2,850
Czechoslovakia	1,360	1,403	1,372	1,369	1,289	1,581	1,684	1,479	1,412	1,587	1,786	1,600
Other Countries[1]	4,060	3,670	4,060	3,930	4,060	3,930	4,060	4,050	3,930	4,060	3,930	4,060
Total	21,188,766	20,271,877	23,170,104	22,889,499	23,982,164	23,283,198	24,334,015	24,653,768	24,050,229	24,578,208	23,327,859	23,793,939

*Based on quarterly returns.

[1] Estimate.
[2] Russian Sakhalin included with Russia.
[3] Anglo-Iranian Oil Company Ltd. figures revised—fuel oil returned to ground has been deducted.
[4] International Petroleum Company and Lobitos Oilfields Ltd. figures combined.
[5] Do not include Assam and Punjab, which are listed separatedly under British India.
[6] Bahrein Petroleum Company Ltd. figures.
[7] British Malayan Petroleum Company Ltd. figures.
[8] Includes natural gasoline production.
[9] Japanese Sakhalin, Taiwan (Formosa) and Hokkaido included with Japan.
[10] Excluding Burma.
[11] Sarawak Oilfields Ltd. figures.
[12] Anglo-Egyptian Oilfields Ltd. figures.

WORLD TOTAL FOR 1937, TONS = 272,625,181

Official Crude Oil Production Figures for 1932 to 1937

	Daily Average 1937 (M. Tons)	Daily Average 1936 (M. Tons)	Preliminary Total 1937 (M. Tons)	Total 1936 (M. Tons)	Total 1935 (M. Tons)	Total 1934 (M. Tons)	Total 1933 (M. Tons)	Total 1932 (M. Tons)
United States	474,219	405,419	172,996,452	148,707,864	134,912,143	122,913,903	122,601,191	106,289,292
Russia	76,222	74,822	27,820,900	27,384,900	25,241,100	24,092,700	21,330,100	21,389,300
Venezuela	75,935	62,692	27,716,258	22,945,299	21,990,373	20,112,115	17,293,193	17,085,334
Iran	28,627	22,780	10,448,880	8,337,487	7,614,988	7,665,507	7,207,180	6,555,387
Netherland India	19,900	17,617	7,263,481	6,437,818	6,081,599	6,054,742	5,534,832	5,099,183
Roumania	19,579	23,782	7,146,575	8,704,000	8,394,000	8,473,355	7,387,000	7,350,321
Mexico	18,913	16,942	6,903,250	6,090,842	5,973,955	5,666,857	5,049,109	4,870,175
Iraq	11,132	11,175	4,123,168	4,079,066	3,724,231	1,048,108	147,943	118,887
Colombia	7,792	7,143	2,844,251	2,614,092	2,452,635	2,416,432	1,833,606	2,287,835
Peru	6,319	6,370	2,306,577	2,331,443	2,260,344	2,161,990	1,756,867	1,311,856
Argentina	6,407	6,017	2,338,775	2,202,304	2,036,903	1,997,706	1,950,499	1,871,882
Trinidad	5,977	5,090	2,181,605	1,862,796	1,642,446	1,533,122	1,345,532	1,425,009
Burma	2,949	2,862	1,076,278	1,047,593	991,456	1,004,951	982,233	976,589
Bahrein	2,910	1,739	1,062,161	635,555	173,072	39,008	4,293	123
Brunei	1,586	1,290	578,810	470,991	471,842	386,478	290,808	171,432
Poland	1,372	1,398	501,000	510,630	514,760	529,200	550,670	556,680
Germany	1,242	1,217	453,451	444,600	427,400	317,500	238,600	229,700
Canada	1,032	519	376,689	190,031	182,820	178,233	144,686	131,937
Japan	972	934	354,804	341,976	326,580	266,520	212,667	239,567
Ecuador	835	752	304,912	275,293	245,434	231,947	229,578	226,423
British India	779	746	284,214	273,137	281,072	265,341	224,879	240,767
Sarawak	575	604	209,860	221,126	253,799	277,513	315,259	332,819
Egypt	447	485	163,151	177,491	176,436	214,671	232,437	265,055
France	195	204	71,082	74,788	74,172	98,025	110,120	105,758
Austria	90	20	32,875	7,477	6,616	4,178	856	120
Czechoslovakia	49	51	17,922	18,665	19,946	25,971	17,776	18,493
Other countries	131	115	47,800	42,000	48,200	54,600	52,000	45,300
Total	766,186	672,785	272,625,181	246,429,264	226,518,322	208,030,673	197,043,914	179,195,224

Foreign Oil Legion

J. V. MURRAY, director in charge of sales and operations for California Texas Oil Company Ltd., returned to New York recently from an inspection trip of the Company's business and facilities in the East. Mr. Murray spent an exciting three weeks in Shanghai during the hostilities. He also visited Hong Kong, the Philippine Islands, Singapore, Ceylon and India, and then paid a visit to Bahrein Island where the modern refinery of Bahrein Petroleum Company Ltd. is now in full operation. Leaving Bahrein Mr. Murray spent some time in Egypt and returned to New York via Europe. Aside from the disturbances in China, Mr. Murray states that he found business generally good in all of the countries he visited in The East.

GEORGE LEGH-JONES, newly appointed director of Shell Transport & Trading Co. Ltd., has been associated with the petroleum industry since the World War when he was in The Admiralty's department of naval stores, which deals with oil supplies and tankers. He had already seen service in France in 1914. In his official capacity he was instrumental in creating the organization responsible for transport of oil in double-bottoms and ballast tanks of passenger liners and freighters—a suggestion of the late SIR MARCUS SAMUEL of which the details were worked out by CORNELIUS ZULVER. After the war Mr. Legh-Jones became directly associated with the Shell interests when in 1919 he joined the management of the fuel and other departments of Asiatic Petroleum Company Ltd. Three years later he went to the United States to become president of Shell Oil Company, as well as director and member of the executive committee of Shell Union Oil Corporation. He spent 12 years in America and then returned to England as manager of Anglo-Saxon Petroleum Company Ltd., of which he is now director in charge of tankship construction and operation. Mr. Legh-Jones has remained a director of Shell Union.

FRANCIS E. POWELL, JR., recently-appointed general manager of the marine sales department of Socony-Vacuum Oil Company, Inc., is now in England and will return to New York shortly to head the world-wide marketing of the company's marine oils. An American, he attended Cambridge University before becoming associated with Anglo-American Oil Company, Ltd. (Jersey Standard's British subsidiary) in 1924. During the years with Anglo-American, he made several trips to the United States to study oil marketing conditions and subsequently became a member of the company's sales committee. In 1930, Mr. Powell became associated with Stanco, Inc., another subsidiary of Standard of New Jersey, in New York. He returned to England in 1933 and became a director of the Vacuum Oil Company, Ltd. Mr. Powell remained in charge of marine lubricating oil sales of that company until his recent appointment.

Hon. Peter Montefiore Samuel, second son of Viscount Bearsted, M.C., and grandson of Sir Marcus Samuel—one of the Shell founders, who has been appointed a director on the board of Shell Transport & Trading Company, Ltd. Although he has gained general oilfield experience in California and Maracaibo, most of Mr. Samuel's career has been tied up with banking and finance, including a year with Brown Bros., Harriman of New York.

Bruce K. Brown

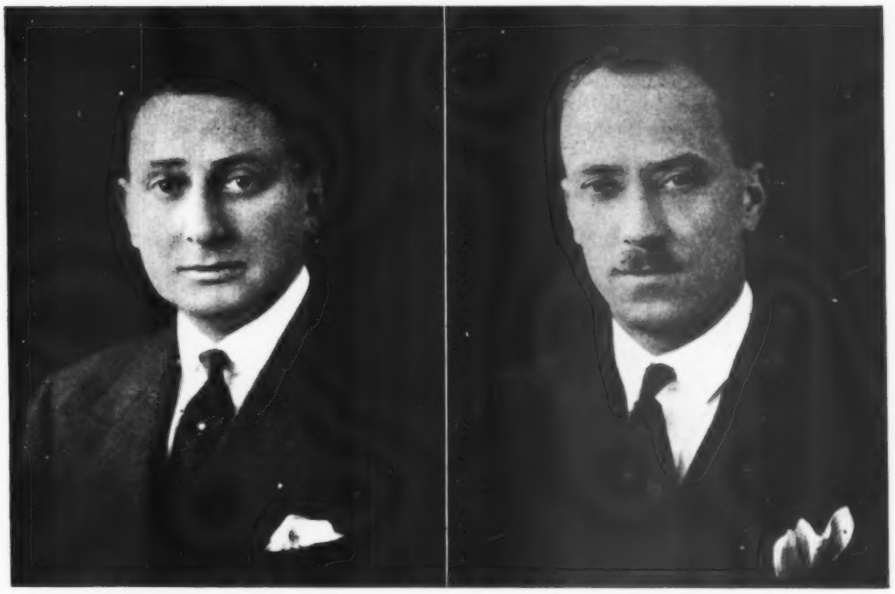
BRUCE K. BROWN was appointed general manager in charge of research and development by Standard Oil Company of Indiana. He will supervise Standard's refinery research laboratories as well as the general activities of the company in connection with patents and technical developments. Mr. Brown holds degrees in chemistry and chemical engineering from the University of Illinois. Formerly a second lieutenant in the Machine Gun Corps, he began his business career as a research chemist for the Burgess Laboratories; later he directed research for Commercial Solvents Corporation and served as the head of its patent and research information departments. Author of numerous articles and one book on nitrocellulose lacquers, he holds a number of patents in the battery solvent and petroleum fields. Mr. Brown has been identified with the development and licensing of various processes in the petroleum industry, being a director of Gasoline Products Company, Gasoline Antioxidants Company, The Lubrication Corporation, and others.

DR. EUGENE R. SMOLEY has been placed in supervision of the newly-established Pacific coast office of The Lummus Company. The office is located at 411 West 5th Street, Los Angeles, with V. O. BOWLES, engineer in charge.

MICHAEL O'SHAUNESSY, well-known expert on South American oil matters, left the United States during the middle of January for a two-month stay in the Venezuelan oilfields.

ALLEN J. ARMSTRONG is vice-president and general manager of the newly-formed Texasteel Manufacturing Company—which came into existence January 1st, 1938, to take over the assets of the oil well supply department of the Texas Steel Company. Mr. Armstrong was educated at the University of Missouri and Massachusetts Institute of Technology, and went into the service of Mexico Gulf Oil Company. Subsequently, he was secretary for a period of 10 years of the Association of Producers of Petroleum in Mexico, resigning August of last year to take charge of the oil well supply department of Texas Steel Company. JESS W. EMERY, vice-president in charge of sales for the new company and formerly sales manager of the same department, has been associated with the petroleum industry for the past 18 years in the role of independent oil producer, as well as in plant production, field installation and pumping equipment.

Allen J. Armstrong



H. I. Caro, managing director, and J. Chillman, director, of R. G. Lane, Ltd., London oil brokers and merchants, who arrived in New York on board the "Normandie" early in February. They expect to be visiting the Gulf ports, New Mexico (Artesia field), and California during their five or six weeks stay.

C. STUART MORGAN, secretary, Near East Development Corporation, returned to New York from Europe about the end of the first week in February. Mr. Morgan has spent many years in the Near and Middle East, particularly during the war, when he was in charge of railroad construction when under constant fire. His company holds a 23¾ percent interest in Mosul Holdings Ltd., which controls Mosul Oil Fields Ltd. and B.O.D. Ltd. It also holds the same proportion of shares in Petroleum Concessions Ltd. and its various subsidiaries, and in Iraq Petroleum Company Ltd. These oil companies are actively engaged at the present time prospecting and drilling in Arabia, Palestine, Syria, Iraq and other countries in that part of the world.

MOWATT M. MITCHELL, in charge of general affairs in Peru for Compania de Petroleo Ganzo Azul, has established his headquarters at Edificio Hidalgo 204-205, Plaza San Martin, Lima. The company's representative at its concession along the Pachitea river, at Agua Caliente, is DOUGLAS FYFE, petroleum geologist and engineer.

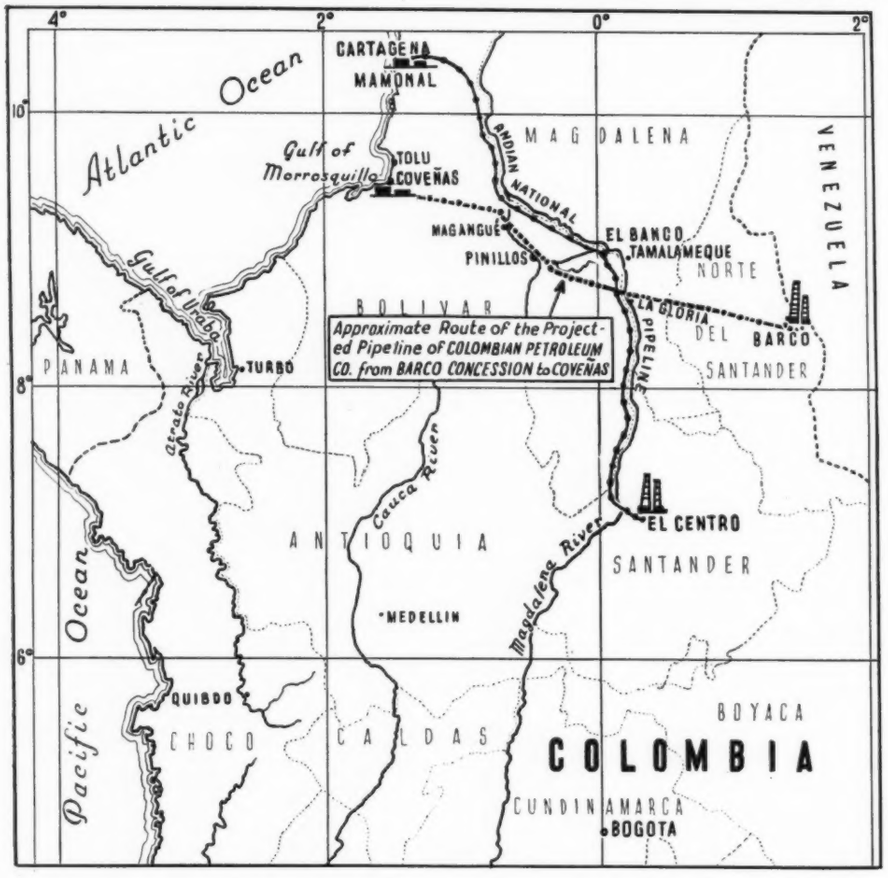
MAX THORNBURG, vice-president of California-Texas Oil Company Ltd., left London early in February en route to Bahrein Island, where he plans to remain for about six weeks. His wife and son are reamining in England while Mr. Thornburg is in the Gulf of Iran. Bahrein activities were reviewed in the OCTOBER 1937 issue of WORLD PETROLEUM.

DR. FISCHER, originator of the well-known Fischer-Tropsch process for manufacture of motor fuel from coal, is now in Cape Town, South Africa. He is negotiating with DR. VAN DER BIJL, chairman of the State Steel Works and the Electricity Supply Commission, for the construction of a $15,000,000 coal-oil distillation plant in the South African coal area. Gasoline consumption in South Africa is about 3,500,000 bbl. per annum, and the projected unit would apparently be part of the plans for rendering the Union of South Africa partially independent of outside sources of gasoline supply.

DOTT. PROF. COMMENDATORE MARIO MARCONI, new general manager of "Aquila" S. A. Technico-Industriale, of Trieste, Italy, was a recent visitor in London. He accompanied his managing director, DR. FRANZ KIND. Dr. Kind also holds the same position with Manchester Oil Refinery Ltd., whose plant at Barton, Manchester, England, is nearing completion. A complete description of the recently completed Aquila plant was published in the MAY, 1937 issue of WORLD PETROLEUM.

Mario Marconi

INTERNATIONAL NEWS



BARCO PIPELINE

FOR a quarter of a century oil men have discussed the Barco concession, in Colombia, as a potential source of petroleum supply. For the past half-dozen years drilling has been under way in this area. Development has now reached the point where the next necessary step is the construction of a pipeline to convey the oil from the field to a deep water shipping port. In December 1937, the Colombian Petroleum Company deposited at Bogota the first $5,000,000 to cover initial payments in construction of the pipeline. Early in January it was made known that contracts had been placed by Colombian Petroleum Company with National Tube Company, Jones & Laughlin Corporation and Republic Steel Company for 24,000 tons of 12¾ in. pipe to be used in the construction of the line and that sometime during 1939 oil would be flowing from Barco to the sea.

While the exact route to be followed by the new pipeline has not been announced by the company, it is reported that its ocean terminus will be at Coveñas on the Bay of Cispata, not far from Tolu and about 60 miles south of Cartagena, a distance of approximately 225 miles from the field. In this case the line will extend entirely across Colombia from east to west and will follow the most direct available route.

Because of the nature of the terrain which the line must traverse, its construction presents great difficulties. Part of the route extends through virtually unexplored jungle and it must cross the eastern range of the Andes. Transportation of the heavy equipment required offers a problem that is now being carefully studied.

HIGH-SPEED TANKERS

REVOLUTIONARY developments in design of high-pressure steam turbines have made tankers with speeds of 16 knots or more an economic necessity of the immediate future in the American petroleum industry, declared J. Edgar Pew, vice-president of Sun Oil Company, when sailing for Australia early in February. "If we can build a carrier that can make two voyages almost as cheaply as a slow ship that can make but one trip in the same time, it follows that we will use the faster vessel." He added that express tankers now projected would not be similar to the 18 knot vessels being built by Jersey Standard, because those include several thousand tons of military features which would be useless for purely commercial production.

OIL SEARCH IN PERU

J. E. BRANTLEY'S Drilling and Exploration Company is carrying out drilling operations on behalf of Cia. de Petroleo Ganzo Azul (Blue Goose Oil Company) on its 900,000 acre concession along the Pachitea river, a few miles above its confluence with the Ucayali river, in Amazonian Peru. The most modern rotary equipment yet developed is to be used, and some 800 tons of machinery, materials and supplies have already arrived in Peru. Headquarters of the company are to be located 30 miles above Masisea, junction for planes of the Peruvian National Air Line, at Agua Caliente. Construction of a landing place, cutting of an eight mile road through the jungle from river to well-site, preparation of the site, and erection of quarters for the American and Peruvian staff have been going on for some time.

CORRECTIONS

In the Annual International Refinery issue of WORLD PETROLEUM for 1937 under the heading "Distillation Progresses from Fractionation to Superefractionation" pages 102, 104 and 105 (pages 24, 26 and 27 of the reprint of this article) figure numbers in the text relating to plans are given incorrectly. Text reference in column 2, page 102 (reprint page 24) figure V-1 should be V-2. Subsequent references to diagrams in this article are one unit low in each case: i.e., figure V-3 should be V-4, etc. On page 110 under the title "Refinery Problems Solved Experimentally" reproduction of Figure 1 was printed upside-down.

COMPRESSOR STATION

A NEW 3,000 h.p. gas booster station has recently been completed at Wilmot, Arkansas, for the Memphis Natural Gas Co. Equipment consists of a new type Super 2-cycle right angle compressor designed and constructed by Clark Brothers, providing higher speed, lighter weight and occupying less floor space than the conventional horizontal type.

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Petroleum Industry. Edited by Dr. O. W. Willcox

GEOLOGY

Occurrence and Accumulation of Oil in the Laredo District, Texas—Herschel H. Cooper, in BULL AM. ASSOC. PETROLEUM GEOLOGISTS, vol. 21 (1937), No. 11, pp. 1422-1438.

During the past few years the Laredo district of South Texas has come into prominence as one of the outstanding shallow oil-producing districts of the United States. The oil is recovered chiefly from shore-line sands of Jackson age, which occur at depths ranging from 160 to 3,500 ft. Accumulation of the oil therefore is in structures primarily of stratigraphic origin, that is, in buried shore-line sands. However, southeastward plunging folds, having axes approximately at right angles to the Jackson strand lines, and normal faults, with strikes oblique or transverse to the strand lines, are ordinarily either essential or important contributory factors in effecting accumulation, especially in the larger and more extensive fields.

Geology and Biology of San Carlos Mountains, Tamaulipas, Mexico—UNIVERSITY OF MICHIGAN STUDIES, SCIENTIFIC SERIES, vol. XII (1937).

This volume contains reports of an expedition to the San Carlos Mountains in 1930, under the direction of Lewis Burnett Kellum, geologist. Accompanying the expedition were a botanist and a zoologist in addition to four other geologists who submit reports on the sedimentary and igneous rocks, and ore deposits of the region. A paper on the geology of the Sierra de Cruillas is also included.

Evaluation of Petroleum in Oil Sands by its Index of Refraction—Hollis D. Hedberg, in BULL AM. ASSOC. PETROLEUM GEOLOGISTS, vol. 21 (1937), No. 11, pp. 1464-1476.

The principal application of the relation between refractive index and commercial quality of petroleum is found in the evaluation of oil sands encountered during drilling. The importance of knowing the quality of oil in a sand at the time it is cored is obvious. However, it is frequently difficult to make a reliable estimate from mere inspection of the core sample. Here the refractometer provides a rapid and convenient method of determining the quality of the oil in a sand with the paramount advantage that only a drop or two of oil is necessary for an accurate determination.

In many richly saturated sands it is possible to find enough free oil in the core barrel or exuding from the surface of the core to give a satisfactory refractometer reading. In other sands where free oil is not available it is necessary to resort to carbon-tetrachloride extraction. The core sample is broken down in a mortar and an excess of carbon tetrachloride is added. After standing for 10 minutes the solution of oil in tetrachloride is filtered into an evaporating dish and the filtrate is evaporated on a hot plate until only a small quantity of liquid remains. The final evaporation is then allowed to proceed at room temperature until all or almost all of the carbon tetrachloride is gone. A thin film of the oily residue is smeared on the surface of the fixed prism of the refractometer, and, after letting it stand for a few more minutes to allow the last traces of carbon tetrachloride to disappear, the refractive index is read. In very heavy oils a few drops of carbon tetrachloride are placed directly on the oil smear and worked around on the prism surface with a wooden swab in order to form a smooth, even film of oil.

DRILLING

Ground Oyster Shells in Drilling Muds—I. P. Sanders, in OIL & GAS JOUR., vol. 36 (1937), No. 28, p. 54.

Few considerations in the oil industry have commanded more study in late years than the problem of drilling through an oil-bearing formation without impairing its productivity. Calcareous drilling fluid is one of the remedies which has been advanced to meet this problem. Extensive experimental work by H. C. Miller and G. B. Shea and reported in Bulletin 3249 of the U. S. Bureau of Mines pointed out that if enough finely divided limestone were added to the mud, the cake deposited against the productive strata could be removed by acid. Carbon dioxide liberated in the reaction serves to agitate the acid and helps to dislodge the clay and other inert parts of the mud cake. This, under favorable conditions, insures completion of the reaction between acid and the calcium carbonate in the cake. It was determined that the addition of 20 to 30 lb. of pulverized limestone would normally produce the desired results, and it was shown that fine division is important.

Since publication of the experimental data, well completions with calcareous additions to mud have been quite extensively used, especially in Mid-Continent fields. These practical applications have served to substantiate the experimental results, and in a number of wells a comparison of productivity with the average of the surrounding wells has clearly indicated the benefits derived from the use of this method. Very large acid shots are used, averaging in the neighborhood of 5,000 gal. Varying quantities of calcium carbonate have been added, but usually 100 lb. is added for each barrel of mud.

When carbonate is used in drilling the entire hole, fishing jobs, such as twist-offs, are more easily dealt with. If circulation can be established around the fish, the use of acid to break down the consolidated mud will usually free the tools. Even when circulation cannot be established, acid is often useful after the washing over process has been carried out.

In California the calcium carbonate most widely used for addition to drilling mud is obtained by crushing unconsolidated sea shells. This material has the advantage of being practically pure calcium carbonate, and upon being crushed it forms flaky or fibrous fragments of relatively thin cross-section. These are more readily attacked by acid than the granular particles which result from crushing a consolidated limestone, and it is believed that particles of this type are more efficient in forming a thin impervious mud sheath over the producing formation while drilling is in progress.

Hardening of Mud Sheaths in Contact with Oil and a Suggested Means for Minimizing Their Sealing Efeect in Oil Wells—C. P. Bowie in U. S. BUREAU OF MINES. REPORT OF INVESTIGATIONS, R.I. 3354, November, 1937.

For year many oil producers have believed that often low-pressure oil and gas-bearing strata have been overlooked in fields where the rotary system of drilling has been used. Collom gave as a reason for this condition that because the mud fluid was thick, the oil or gas stratum was plastered and sealed as the tools passed through it and no oil showed at the surface. Although this observation was made 15 years ago, it may often still be true notwithstanding modern developments in coring and electrical logging.

Operators have believed, also, that mud fluid does not solidify behind the casing. Lewis and McMurray stated: "All the evidence obtainable from practical experience points to the fact that the mud fluid properly mixed and employed does not solidify the casing, even in deep wells and after long periods."

This statement may be true where the mud fluid is in contact with water-bearing formations, but the author of this paper believes that other conditions hold where the mud fluid is dehydrated, as it can be by contact with crude oil. The fact that quies ent mud does harden in contact with oil was proved by laboratory experiments.

The problem thus arises of treating drilling muds so that they will not harden and thus hide oil horizons that might otherwise be discovered and exploited. Various substances were examined from this point of view. Asphalt, chicle gum, rosin, zinc, stearate, and crude rubber, especially the latter, seem to have possibilities. None of these have been tested in actual oilfield work but the author feels that the proposition will turn out to be practicable.

Damping Rotary Rig Ground Vibration—Charles C. Lynde, in PETROL. ENG., vol. 9 (1937), No. 2, pp. 55-56.

During drilling of a 6,000 ft. well on the Gulf Coast the ground would vibrate in a very noticeable manner when the draw works were being run rapidly, as when pulling cores. These vibrations eventually caused the boilers to lean to such an extent that a steam line cracked. Other effects of the vibrations were observed in the neighborhood. After some cogitation it was decided that the vibrations were not due to the action of the drill far underground, but the vibrations of the surface

equipment which were propagated through the surface deposits of earthy matter. On this theory a ditch was dug across the lease between the rig and the boiler setting. The ditch was then filled with baled hay, with scrap iron piled on to keep the hay in position. After this was done it was found that the draw works could be raced at top speed with only the faintest indication of vibration on the other side. The device was so successful that it was made standard practice for other wells in the vicinity.

The incident is held to show that deep drilling is not responsible for the vibrations that give rise to damage suits in congested districts. In such cases mufflers of this kind will doubtless, in most cases, overcome or mitigate the nuisance.

OIL WELL OPERATION

Prevention of Oilfield Emulsions—J. S. Surfluh, before AM. PETROLEUM INSTITUTE, Chicago, November, 1937.

The prevention of emulsions can be accomplished by:

1. Reducing the degree of agitation.
2. Producing physicochemical conditions unsuitable for emulsion formation.
3. Separating the water before agitation takes place.

All three methods are used, but the first is the most important.

The origin of oilfield emulsions can be ascribed to turbulence in the following places:

1. Well pumps.
2. Tubing.
3. Flow lines.
4. Transfer pumps.

Prevention in the last two groups has made the greatest amount of progress because of more opportunity to make large savings. However, the first two groups should be investigated, if any dehydration trouble is encountered or if the dehydrating costs are high.

Some operators have secured greater dehydration economies by eliminating emulsions than by improving dehydration methods and equipment during the last year or two. For this reason, further investigation of this subject should prove of economic value.

Oklahoma City Field Pumping—B. M. Moroney and F. R. Wheeler, before AM. PETROLEUM INSTITUTE, Chicago, November, 1937.

For producing at low rates of flow, hydraulic and sucker-rod pumping are in direct competition with one another. At high rates of flow the centrifugal pump is outstanding. In general, there is little actual difference in the three pumping methods mentioned as to cost per barrel produced. Some operators, however, claim lower-per-barrel costs with the hydraulic pump.

The advantages of sucker-rod pumping are: It is simple in principle, and the present personnel is fairly familiar with the equipment. The disadvantages are: It does not fit all types of wells, such as crooked holes; service equipment and labor requirements are large; it requires considerable replacement of material; and has the low over-all efficiency of 27 percent.

The advantages of hydraulic pumping are: It has low cost of installation and operation; it is generally adaptable to all types of wells of moderate and small flowing capacity; its efficiency is not affected by crookedness of the holes; well conditions are easily determined by action of pressure gauge at surface; and it has the high over-all efficiency of 60 percent. The disadvantages are: It requires trained personnel, and thoroughly-cleaned power oil; it is difficult to start in operation; and paraffin trouble is excessive.

The advantages of centrifugal pumping are: It produces at high rates of flow. Disadvantages are: It cannot be economically adapted to wells of small capacity, nor to some wells of large capacity which require handling of excessive quantities of sand or free gas; it does not deplete the sand as well as other methods; it has the low over-all efficiency of 36 percent; furthermore, high speed equipment is usually short-lived.

Selection of Screen Openings for Unconsolidated Sands—C. J. Coberly, before AM. PETROLEUM INSTITUTE, Chicago, November, 1937.

Free entrance of oil with exclusion of sand is the function of screen pipe. To perform this function properly, the screen opening, regardless of type, must bear a definite relation to the grain size of the sand.

Tests under simple, ideal conditions, using spherical grains of one diameter, show that a stable bridge is established when the width of a rectangular slot is two times the grain size or when the diameter of a circular opening is three times the grain size. With openings exceeding these values by approximately 25 percent, no bridge will form.

Angular grains will form a stable bridge under the same conditions as spherical grains. Due to the angularity of the grains, the point at which bridging ceases is extended to openings approximately 50 percent in excess of these values for the samples investigated.

Tests with mixtures containing two sizes show that the bridging influence of the larger grain is great in relation to the amount present.

Unconsolidated oil sands with typical grain distribution will form stable bridges if the opening in the screen which retains 10 percent of the sample is taken as the diameter of the bridging grain and the rules for uniform spherical grains applied.

Methods and apparatus used for making these determinations are discussed.

Use of Data of Build-Up of Bottom-Hole Pressures—Morris Muskat, in TRANS. AM. INST. MINING AND METALLURGICAL ENGINEERS, (Petrol. Development and Technology), vol. 123 (1937).

The theory is developed for the rise of the fluid level or bottom-hole pressure after shutting in a well in which the production rate is proportional to the pressure drop over the sand. The result is an exponential increase of the fluid level or bottom-hole pressure with the time after shutting in. From a determination of the slope of the straight line giving the time variation of these data when plotted on semi-logarithmic paper, the production capacity of the well for any back pressure can be calculated, as well as its maximum pumping capacity. The adjustment of the plot to give a straight line also affords an accurate means of determining the reservoir pressure about the well.

REFINING

Observations on Mixing Oils—F. Schick, in OEL UND KOHLE, vol. 13 (1937), No. 44, pp. 1157-1161.

Oils are frequently blended in order to equalize the different properties of the component oils. In particular, an inferior oil is often improved by mixing it with a better one.

The author here draws attention to certain consequences of mixing oils of different origin, with special reference to the storage stability of the mixture, or its tendency to deposit gummy sediments consisting of polymerization products and substances of resinous or asphaltic nature. It is a fact that when two lubricating or two Diesel oils, both of which may show satisfactory figures for the Indiana test, are mixed, the mixture may give a much less satisfactory aging test than either of the components taken separately. This is because the solubility relations of the gum-forming substances are changed by the change in the hydrocarbon mixture in which they were originally dissolved; in any case, the gummy substances appear earlier and more copiously during the subsequent storage. The deterioration of stability of the mixture is the greater the greater the difference in stability of the two components. This means that mixtures of oils of very unlike qualities are to be avoided, especially if one of the components contains a high percentage of saturated hydrocarbons.

The action here is ascribed to the fact that pure paraffin oils are not the best solvents for gummy ma ters and their effect in mixtures is to throw the gums into a form of an unstable colloidal suspension.

It is shown by experiment that a mixed oil yields to a mild refining treatment with a small quantity (one percent or less) of sulphuric acid much more readily than the separate oils; hence acid treatment, followed by a light clay treatment will improve the aging quality of the blend as nothing else will—not even a redistillation.

Vacuum Decomposition of Petroleum Residues—W. L. Nelson, in OIL & GAS JOUR., vol. 36 (1937), No. 28, pp. 62, 64.

Attention is called to the increased usefulness of vacuum decomposition of refinery residues and bright stocks, which can be converted into neutral oils that command a better price than bright stock. Another important application at the present time is in the manufacture of Diesel oil, the market for which is rapidly widening. The process involves nothing more difficult than decomposing a bright stock or a Mid-Continent semi-solid asphalt to coke at pressures of 14 to 380 mm. The distillate is topped to reduce the flash point.

New Process for Continuous Coking Distillation of Crude Oil, Fuel Oil and Petroleum Residues—Julius Bauer and Augustin Venzano, in PETROLEUM, vol. 33 (1937), No. 45, pp. 5 - 10.

This article describes a coking distillation installation covered by German and Austrian patents. The invention consists essentially of making the lower part of the coking still detachable so that it can easily be removed for cleaning out the accumulated coke, a clean bottom put in its place, and distillation resumed with a minimum of down time. The results of the customary method are compared with the results obtained with the new method (Astra coking process).

Simplification of the Copper Sweetening Process—Walter A. Schulze and A. E. Buell, in OIL & GAS JOUR., vol. 36 (1937), No. 28, pp. 56, 57, 59.

The authors discuss the copper process for sweetening gasoline under the title "Control of Copper Sweetening Centralized in a Few Variables".

The centralization here referred to is based largely on the discovery that the sweetening power or reactivity of copper chloride solutions as oxidizers of mercaptans in gasoline can be accurately controlled by measuring the relative oxidation potential of the copper solutions. When the concentration and other

characteristics of the treating solutions are controlled so that this oxidation potential is kept within certain limits the sweetening of certain gasolines, and especially cracked gasolines, can be regulated so as to yield very superior products.

The factors which affect the oxidation potential are temperature of the solution, concentration of the cupric copper solution, and concentration of cuprous copper. The oxidation potential rapidly increases with temperature, so a more dilute solution should be used with hot than with cold gasoline stream. Oxidation potential also increases with increase in the concentration of pure cupric chloride in the solution, but here it is noted that the oxidation potential for any one system is a function of the logarithm of the ratio of oxidized to reduced form and that in the more dilute solutions the copper chloride is relatively more active than in the more concentrated solutions. By controllizing and standardizing these variables "extremely satisfactory results have been obtained". Contributory factors are pH and the use of alkaline sulphide for stabilizing the gasoline. The process is most effective when air is dissolved in the gasoline, which may be effected under pressure.

The usual loss of octane when sweetening by the older methods is normally avoided by copper sweetening, as the mercaptans are converted into disulphides and not in part to higher alkyl polysulphides.

CHEMISTRY

Compressibility of Liquid Naphthalene—by F. R. Russell and H. C. Hottel, before petroleum division am. chem. soc., Rochester, 1937.

Data obtained in connection with an investigation of the polymerization of ethylene dissolved in naphthalene permitted a determination of the density of the latter, at temperatures up to 850 deg. F. and pressures up to 400 atmos. The results, of estimated accuracy of 0.1-0.2 percent, are presented graphically. The density varies from 1.007 to 0.967 as the pressure drops from 6,000 lb. to nothing, at 200 deg. F.; from 0.765 to 0.696 as the pressure drops from 6,000 to 3,000 lb., at 850 deg. F.

Sulphuric Acid Extraction Methods for Determining Olefins and Aromatics in Hydrocarbon Oils.—C. H. Fisher and Abner Eisner, in bureau of mines report of investigations No. 3356, December, 1937; 15 pages.

Sulphuric acid of various concentrations has long been used as a reagent in the determination of olefins and aromatics in hydrocarbon oils such as gasoline, kerosene, and neutral oils from coal-tar distillates. Despite its long use, however, there is no general agreement as to optimum conditions and concentration of acid, and numerous methods and modifications have been recommended. In most cases, treatment of the neutral oil with 80 to 90 percent sulphuric acid, followed by distillation to the original endpoint to remove olefin polymers, is recommended for the estimation of unsaturated hydrocarbons. The distillate thus obtained is taken as olefin-free oil and used in later stages of the analysis. Aromatic hydrocarbons generally are determined in the olefin-free oil by sulphonation with more concentrated acid (96 to 100 percent and fuming sulphuric acid are recommended), the hydrocarbons not attacked and removed as water-soluble sulphonic acids being considered as saturated hydrocarbons. In some cases the saturates are examined further by differentiating between cyclic (naphthenes) and acyclic hydrocarbons (paraffins). Generally this is achieved by physical methods, although strong sulphuric acid is known to react preferentially with some types of saturated hydrocarbons.

It was the purpose of the present work to make a general study of this type of analysis and to investigate the reactions of hydrocarbons under conditions often used in analyses that employ sulphuric acid reagents.

Using two synthetic solutions, several previously described sulphuric acid methods for determining olefins and aromatics were compared. Although no one method was completely satisfactory, the Kester and Pohle procedure (olefins determined with 80 percent acid) gave the most accurate results.

In the determination of olefins, reagents such as 80 percent sulphuric acid, while quite effective with reactive olefins, fail to dissolve or polymerize the more unreactive olefins (diamylene, cetene, etc.). Sulphuric acid of higher concentration is more effective but its use is limited because of its tendency to attack aromatics and catalyze the interaction of olefins and aromatics. Acid of concentration slightly higher than 80 percent may be used satisfactorily for oils of low aromatic content. Coal-tar oils containing large quantities of aromatic hydrocarbons require weak olefin reagents, such as 80 to 82 percent acid. When 80 percent acid is used with oils containing unreactive ethylenic hydrocarbons, low olefin and high aromatic values may be expected.

Previous claims that the addition of silver sulphate or boric acid to sulphuric acid gives olefin reagents of enhanced effectiveness have been confirmed. However, these inorganic substances cannot be used to advantage because other reactions of an undesirable nature are promoted.

Formation of Organo-Metallic Alkyl Derivatives of Aluminum During Polymerization of Ethylene—F. C. Holland, A. W. Nash, in jour. inst. petroleum technologists, vol. 23 (1937), No. 169, pp. 679-687.

The reaction of ethylene under pressure with aluminum chloride has been shown to be fundamentally changed by the presence of metallic aluminum. Under suitable conditions of temperature a high yield of a reactive organometallic compound of aluminum is obtained, analogous to the reactive metallic alkyls. The isolation of the liquid compound, which is spontaneously inflammable in air, is described. The properties of the fraction indicate it to be a mixture of the aluminum ethyl chlorides, the existence of which has not previously been reported. By reaction with sodium chloride, formation of a double compound is observed, and the analysis of the residual liquid corresponds closely with that of aluminum diethyl chloride. The catalytic polymerization of ethylene under pressure at 300 deg. C. by the aluminum diethyl chloride fraction has been investigated. The nature of the polymerization products—ethylene homologues of relatively simple constitution—is in accordance with the reaction mechanism proposed by Taylor and Jones for the polymerization of ethylene by free ethyl radicals.

Polymerization of Pure Olefins—F. Jostes and W. Bartels in oel und kohle, vol. 13 (1937), No. 44, pp. 1166-1172.

Polymerization reactions have acquired decided importance in the mineral oil industry within the past few years. It would be a great help in the study of these reactions if something could be learned of the course they take, that is, what intermediate compounds are formed before the reaction comes to an end in the final product.

With a view to isolating such intermediate products the authors studied the catalytic polymerization of heptene, octene, dodecene and propene. No definite polymers were obtained with such catalysts as zinc chloride, tin tetrachloride, concentrated sulphuric acid or aluminum chloride. With phosphoric pentoxide and heptene a polymer was obtained that seems to be a dimer of heptene, boiling at 105-107 deg. C, but the structure of this dimer could not be established. Dimers of octene and dodecene were also obtained.

While definite polymers of propene could not be obtained, the experiments are of interest in another sense. Whereas polymerization of the C_7 to C_{12} olefins always resulted in products of gas oil character and in fact did not go much beyond the dimer stage, the polymerization of propene with phosphorous pentoxide gave lubricating oil fractions along with gasoline and gas oil fractions.

Electrometric Titration of Acids in Oxidized Oils—A. R. Rescorla, F. L. Carnahan, and M. R. Fenske, in ind. eng. chem., analyt. ed., vol. 9 (1937), No. 11, pp. 505-508.

An electrometric method using tungsten-platinum electrodes has been developed for the estimation of acids in oxidized petroleum. The used oil is dissolved in a mixture composed of equal parts by volume of isoamyl alcohol, benzene, and carbon tetrachloride and saturated with lithium chloride. The base is prepared by dissolving sodium in isoamyl alcohol.

Results for pure organic acids dissolved in solvent are reproducible within 0.2 percent; the average difference of the observed from the calculated values is 7 percent. Check determinations on used oils have a maximum deviation of 10 percent.

Test for Ethyl Lead and Observations on Volatility of Tetraethyl Lead—Hans Siebeneck, in oel und kohle, vol. 13 (1937), No. 45, pp. 1193-1195.

In working out a method for estimating lead in drinking water the author found dimercaptolthiodiazol more suitable than picrolonic acid and other organic reagents. With lead this reagent forms an egg-yellow precipitate even in great dilutions. The limit of sensitivity in water analysis is 3 mg/liter.

For the qualitative test of lead in motor fuels the author uses a two percent solution of bromine in carbon tetrachloride and a one percent water solution of dimercaptolthiodiazol; four or five cc. of gasoline are treated with 10 drops of the bromine solution and shaken until decolorized; one cc. of water is added to dissolve the lead bromide that has been formed and then two drops of the dimercaptolthiodiazol reagent. As little as 0.00002 gr. of lead per liter can be detected.

The volatility of tetreathyl lead in gasoline was investigated with the help of this reagent. Three gasolines of different boiling ranges were leaded with 0.09 percent of ethyl lead, and distilled in the A.S.M.T. apparatus. Lead was found in all fractions of all three gasolines and in all cases the first (lowest boiling) fraction contained the most lead. In petroleum ether (boiling range 30 deg. to 50 deg. C.) lead was found in the first drops that distilled at 30 deg. This shows that ethyl lead may volatilize from gasoline even at ordinary temperatures.

Laboratory Method for Testing Stability of Aviation Motor Oils—D. J. Kolomazki and L. I. Stefanzoff, in petroleum (Motoren-Betrieb u. Maschinen-Schmierung), vol. 33 (1937), No. 38.

A study of analyses of used oil has shown that the contaminating substances are chiefly asphaltic and

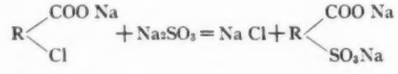
resinous substances, along with some free carbon; the amounts of oxygen compounds, as shown by the saponification and acid numbers, are relatively small. This circumstance raises the presumption that the presence of asphaltic and resinous substances in used oil is in all probability not a result of oxidation processes in the motor, but is rather to be ascribed to cracking processes which take place in those parts of the motor where the oil is exposed to a high temperature. Such cracking processes are pe haps most intensive in the combustion chamber; here, on the one hand, the oil splits off light products and on the other hand condenses to asphaltic products which cause gumming and give rise to the black crusts that are seen when the motor is opened. If this is the case, then stability or aging tests of motor lubricating oils, based on oxidation tests, such as the Sligh test, are hardly to be regarded as founded on the correct principle.

On these premises the authors have worked out a sort of cracking test to be applied to the oils in question. The operation is as follows: 100 cc. of the oil is measured into a tarred normal Engler distilling flask and weighed. A mercury thermometer is immersed in the oil and the flask is connected with a condenser and receiver. The temperature of the oil in the flask is raised within 15 minutes to 415 deg. C. and maintained at that temperature for one hour. The amount of distillate obtained is noted. After cooling, the cracked residue in the flask is investigated by determining the content of precipitated substances (insoluble in benzine), the saponification number and the acid number. The percentage content of substances insoluble in benzine, multiplied by 100, gives the stability number of the oil.

Analyses of oils tested by this method, and of the same oils after use in airplane engines, show close parallelism in the figures for benzine insoluble, saponification number and acid number, which would seem to indicate that the test is along the right line.

Sulphonaphthenic Acids—S. V. Pilat and M. Turkiewicz in PETROLEUM, vol. 33 (1937), No. 41, pp. 1-4.

Working on naphthenic acids separated by selective solvation (phenol) from a petroleum distillate boiling at 200 deg.—300 deg. C. these acids were first chlorinated and then transformed into sodium sulphonaphthenates by the reaction:



Various esters were also prepared and their properties invested.

Chemical and Physical Properties of Dicyclic Naphthenes. I. Cis and Trans Decahydronaphthalene—by W. F. Seyer and R. D. Walker, before PETROLEUM DIVISION AM. CHEM. SOC., Rochester, 1937.

Little is known about the chemical and physical properties of dicyclic naphthenes. Many discrepancies exist even in regard to the simplest member of this series, decahydronaphthalene. There are two forms cis and trans; the reported densities lie between the values $d^{20}/_4 = 0.8695$ and 0.8940, the refractive index $N^D/_{20}$ between 1.4795 and 1.46958. A review of the literature indicates that no synthetic method has been discovered which will yield only one form alone without other impurities. Hydrogenation of naphthalene gives both forms simultaneously. It was found that rectification at a pressure of 10 mm. in a special type of distillation apparatus yielded considerable quantities of both trans and cis forms in a fair state of purity. The rectifying tower was of pyrex glass with an overall length of 2.5 and 2.5 cm. in diameter. It was lagged and heated by a few turns of nichrome wire. The packing consisted of no. 18 galvanized jack chain. The reflux ration was about one hundred to one and was controlled by a capillary tube outlet of a predetermined size. The fractions were collected in a special vacuum receiver already described. A fraction amounting to 425 cc. and having a B.P. range of 69.5—69.7 was collected as pure cis and another fraction, 265 cc. having a B.P. range of 62.7—62.9 deg. was regarded as the pure trans. These fractions were then frozen and about 30 cc. of solution drained off each time. After the third crystallization in each case no change in the freezing points could be detected when a resistance thermometer was used.

The physical properties of these constant freezing point materials are given.

The density of various solutions of the two forms were measured and can be expressed by the equation C = 3395—3788 d., where C is the per cent. of trans and d the density of the mixture. The relation between composition and refractive index can be expressed by the equation C = 12936 — 8734 n, where C is percent. trans and n the refractive index of the D line at 20 deg. C. The eutectic temperature lies between -60 deg. and -70 deg.

Study of the Liquid-Vapor Phase Equilibrium Relations in the Ethane-n-Heptane System—by W. B. Kay, before PETROLEUM DIVISION AM. CHEM. SOC., Rochester, 1937.

The P-V-T relations of five mixtures of ethane and n-heptane of known composition were determined at the liquid and vapor phase boundaries from below room temperature to the highest temperature at which the liquid and vapor could co-exist. From these data the T-X diagrams of the coexisting liquid and vapor at constant pressure were constructed and a comparison made with those computed by means of the solution laws. The results of this comparison show that the solution laws corrected for the departure from ideality of the gas and liquid phases by the use of fugacity, apply reasonably well to these mixtures until pressures in the neighborhood of the critical pressure of n-heptane are approached. In the critical region these laws break down completely. Equilibrium constants were obtained for ethane and heptane. Those for ethane at high temperature differ considerably from the predicted while those for heptane are in good agreement with the predicted except at high pressure.

Petroleum Wax: Determination, Analysis, and Conclusions About its Composition—D. S. McKittrick, H. J. Henriques and H. I. Wolff, in JOUR. INST. OF PETROLEUM TECHNOLOGISTS, vol. 23 (1937), No. 168, pp. 616-641.

A method of determining the wax content of oil and the oil content of wax has been developed that appears to be more accurate and reproducible and of much wider applicability than any previously published. The wax is crystallized from ethylene dichloride at —35 deg. C. or from chloroform at —55 deg. C.

Determination of melting-point and refractive-index distributions of the different waxes in a mixture, separated by stepwise crystallization at successively lower temperatures, is a useful way of characterizing the wax.

Low-melting waxes, which must be removed to produce oils of low pour-point, have been found in oils together with the expected high-melting ones. High-melting fractions of distillate waxes contain large proportions of normal paraffins. In fractions with successively lower melting points, isoparaffins, naphthenes, and probably also aromatics, in that order, may predominate. The higher-melting fractions of residue waxes are not predominantly normal paraffins, but contain also large proportions of hydrocarbons of other series. Although American crudes, Eastern, Mid-Continent and Western, differ considerably, the compositions of the waxes from the distillates from the three types are very similar. The waxes from the residues differ, showing characters related to those of the parent crudes.

Petrolatums have been shown to be mixtures of moderately hard waxes with oils of low pour-point.

SUBSTITUTES

Gasogene in China—From CHINA MOTOR AND TRANSPORT, vol. I (1937), No. 4.

A two-and-a-half ton bus, powered by a Diesel engine and using vegetable oils as fuel, made a trial run of 4,109 kilometers (about 2,738 miles) from Shanghai to Kunming. A total of 410 gal. of oil was used; this oil consisted of local vegetable oils purchased as needed along the way—peanut, tea, tung, poppy, cotton and cabbage seed oils; the oil consumption averaged around eight and nine miles per gal. All these oils functioned well except tung oil, which showed a tendency to foul the engine. Only two gallons of mineral lubricating oil were consumed on the trip.

Accompanying this Diesel bus was a similar vehicle powered by a gasogene-driven engine, using charcoal as fuel. This bus broke down on the way, allegedly due to carelessness in attending to the lubricating system. It is considered that these tests indicate the feasibility of using native fuels for motorized transport in China, due to the relative cost of imported petroleum products.

Utilization of Compressed Gas—A. Pignot, in REV. PETROLIFERE, No. 763 (1937), p. 1698.

Since July 1st, 1937, all public services, enterprises or transport companies for hauling passengers or freight in France, which possess at least ten trucks or other automotive vehicles of an industrial or commercial nature, are obliged to employ a fuel derived from forest products in the operation of at least 10 percent of their rolling stock. In exceptional cases the Minister of Public Works may authorize the use of fuels derived from other materials of national origin.

The author points out that for the success of such laws it is necessary for a regular and dependable source of supply to be organized. At present this condition is only partly fulfilled in France. No comprehensive supply of wood products for the use of traveling gasogenes appears to be in existence. Until this is done a principal reliance must be on compressed gas, which would come under the definition of national fuel. In all France there are at present about 30 centers at which compressed gas is dispensed to automotive vehicles.

Victory of Motor Alcohol—Leonardo Truda, in BRASIL AZUCAREIRO, vol. 10 (1937) No. 2, pp. 93-105.

All gasoline for automotive purposes used in Brazil is required to be mixed with absolute alcohol to the full extent of the available supply of alcohol. As a result the alcohol industry based on sugar cane has received a marked impetus. There are now a total of 26 absolute alcohol distilleries in full opera-

tion in the country, producing 65,472,780 gal. a year. When all the new plants under construction, contracted for, or projected, are completed, the daily production will be greatly increased. The present mixing rate is 17.56 percent and, at that rate, the present supply of alcohol is scarcely a fourth of what is needed. The alcohol industry can, therefore, expand to four times its present dimensions and even more, because consumption of gasoline in Brazil is rapidly increasing. Many of these alcohol plants have received financial assistance from the government.

The compulsory use of alcohol for automotive purposes is motivated partly from a desire to assist sugar cane farmers, and also to save on foreign exchange involved in the importation of foreign gasoline, as no petroleum deposits have as yet been found in Brazil.

On Blending Mineral Lubricants with Vegetable Oils—A. Balada, in PETROLEUM, vol. 33 (1937), No. 40, pp. 1-8.

In countries where there is a shortage of natural petroleum supplies there is a standing temptation to experiment with substitutes, particularly with vegetable oils that are produced locally. In Italy and other countries where the olive tree flourishes these attempts have centered principally on olive oil, with the general result that this oil has been found unsuitable for lubricating automobile engines, a fact which the author again proves by his own experiments.

In Germany the most easily obtainable vegetable oil is rape oil. This, either alone or mixed with olive or mineral oil, is very unstable; it quickly becomes acid, acts corrodingly, becomes thick and easily forms emulsions. Used in automobile engines, it increases oil consumption, clogs the filter and tubing, forms carbon, provides poor lubrication and quickly wears out the engine. No catalyst has been found that will cure these defects.

Exploitation of Oil Shales at Thelots, France—REVUE PETROLIFERE, Special Number, 1937.

The Autun basin contains a series of sedimentary deposits several thousand feet thick containing numerous layers of bituminous shale (Permian age) of thicknesses varying from 2¼ up to nearly 250 ft.

Micro-paleontological studies show that these shales were deposited as layers of fine clay intermingled with the remains of algae identical with species now living in Russian and Siberian lakes. Deposition evidently occurred in the central part of a large body of water through a long geological period, during which the organic matter of the remains of the algae was transformed into petroleum. Near the shores of this ancient sea the oil shales are mixed with much sandy material. The central basin containing the richest deposits has an area of about 240 sq. km. (about 150 sq. mi.).

Since the war these schists have been prospected at several places, and a fully equipped plant for obtaining shale oil is now operating at Thelots (erected in 1936). The mine workings extend to a depth of some 300 ft.; operations are at present confined to a layer of shale about 10 ft. thick containing about 60 liters (about 16 gal.) of oil per ton. Numerous other layers of varying thickness and oil content are contained in the same section.

The shale is mined like coal and hoisted to the surface at the rate of 100,000 to 120,000 tons a year. Much blasting is necessary to dislodge the hard shale. From the mine the shale is received in 120 vertical Pumpherston retorts 18 m. high and 75 to 85 cm. in diameter. The upper part of the retort is heated externally to 450-500 deg. C. by burning incondensible gas produced in the operation. Additional heat is obtained by injecting steam into the hot residue at the bottom in order to convert the fixed carbon of the burnt shale into water gas, which is burned by injecting air. The oil distillate has a specific gravity of about 0.900 and contains little asphalt. After separation from the ammoniacol vapors and a small amount of gasoline the oil distillate is given an acid and an alkali wash to remove organic bases and phenols and is then either fractionated into kerosene, gas oil, and residues, or cracked to obtain 65 octane gasoline, depending on market conditions.

The present output of crude distillate is about 30 tons a day. The cost of production is high, and operations are justified only by a high protective tariff. However, it is planned to enlarge the mine to the point of producing 1,000,000 tons of shale per year by the installation of labor saving machinery similar to that used in coal mining.

The total reserve of oil-bearing shale in this basin is enormous, but naturally only those layers containing oil in appreciable quantities come into consideration. The four richest layers are estimated to contain about 21,000,000 tons of workable shale, whereas if an oil content of 60 liters per ton and a depth of 600 m. are taken as economic limits the reserves amount to 100,000,000 tons.

Influence of Distillation Pressure on the Amount and Quality of Diesel Motor Fuel from Brown Coal Tar—Heinze in OEL UND KOHLE, vol. 13 (1937) No. 46, p. 1218.

Tars from the low temperature carbonization of brown coal were distilled at pressures ranging from 20 mm. up to 10 atmos., After redistillation, refining and dewaxing the various distillates were examined and tested as to their quality as Diesel fuels, including yield, fire point, and cetene number.

It was found that the best values in all respects were obtained within the pressure range of 1 to 2 atmos. Under these conditions the yield of Diesel fuel of 47 to 48 cetene number was 69 percent. At higher distillation pressures the more heat-sensitive hydrocarbons were split into gasoline-like fractions.

Shale Oil Production in Esthonia—Keltser, in OEL UND KOHLE, vol. 13 (1937), No. 44, pp. 1139-1149.

Esthonian oil shales occur in the Kukersite stage of the Ordovician. The total workable area is estimated at 2470 sq. km. (953.6 sq. mi.). Including some thin horizons of low bitumen content in the south the reserve of oil shale is estimated at 3,500,000,000 tons. On the basis of a 20 percent yield of oil, now attained by the plants in operation, the visible oil reserve is about 700,000,000 metric tons (about 5,000,000,000 bbl.). The general geological section shows eight distinct oil shale horizons. The content of organic matter and ash varies from one layer to the next and also from one locality to another. The average is fairly represented by the cross section at Kivioli, which shows organic substance 36 percent, mineral ash 46 percent, and CO_2 18 percent; total, 100. The average yeild of oil is here 24.5 percent of the dry shale, or 65 percent of the organic substance.

The quantity of shale mined in 1937 is estimated at one million tons, of which about two-thirds was subjected to dry distillation; the rest was used directly as fuel. In the distillation process the shale begins to soften at 350 deg. C. Volatilization of oil begins at 400 deg. to 450 deg. and ceases at 480 deg. Between 420 deg. and 440 deg. the process is exothermic. The distillation temperature must be rapidly reached, otherwise the shale softens and clogs the still. Various types of stills are employed, such as the Pintsch and the Davison retorts as well as tunnel and grate furnaces. Heat for the operation is obtained by burning the non-volatile residue in the ash, together with the non-condensible gases.

The yield of gasoline and kerosene is small; the principal product is a heavy oil which is worked into fuel oil, bitumen and asphalt products, and a considerable amount of phenolic substances. In many respects the present operations are inefficient; a considerable amount of low boiling products that might be recovered is lost.

USE OF PETROLEUM

Diesel Engine Deposits as Influenced by Fuel Types and Operating Conditions—J. R. MacGregor and W. V. Hanley, before SOC. AUTOMOTIVE ENGINEERS, Detroit, January 1938.

In those Diesel engines which are critical to fuel deposition, a decrease in operating temperature and load or an increase in altitude increases the quantity of deposits formed. In those engines increasing the average volatility of the cetane number of the fuel decreases the deposit.

An approximation of the deposition tendencies of distillate fuels in engines which form appreciable amounts of deposits may be obtained from the Conradson Carbon of the 10 percent bottoms remaining after 90 percent has been distilled off in the conventional A.S.T.M. gas oil distillation. For fuels of this type the usual Conradson Carbon test fails to correlate with engine deposits. For residual type fuels the Conradson Carbon test provides a convenient means of predicting engine deposition characteristics while the Conradson Carbon of the A.S.T.M. distillation 10 percent bottoms is valueless.

In those engines in which fuel deposition is slight no consistent difference between fuels and no correlation with physical properties of the fuels are apparent.

These tests covering a wide variety of engine designs, fuels and operating conditions have demonstrated that th engine designer has greater control over the quantity of deposits formed in the engine than eithe the fuel refiner or engine operator as indicated by the test results presented in which the ratio of deposits were 20 to 1 between extremes in engine design, 10 to 1 in operating conditions and 3 to 1 between extremes in distillate fuels.

1937 Road Knock Tests—T. A. Boyd, in Committee Report before SOC. AUTOMOTIVE ENGINEERS, Detroit, January, 1938.

This paper deals with the road-test portion of the extensive efforts made during 1937 by the Co-operative Fuel Research Committee to get as precise a correlation as possible between the laboratory knock ratings of automobile fuels and their corresponding ratings in cars on the road. Two series of fuels were designated for this work. One of these was a series of 19 different fuels of conventional winter volatility and representing a wide variety of gasolines; the other was a corresponding series representing the same types of gasoline but having summer volatility characteristics.

When the ratings of all fuels are included, the motor (A.S.T.M.) method appears to give the best average correlation both in winter and summer. An examination of the correlation charts shows that while the correlation is reasonably good for fuels of moderate sensitivities, individual fuels which were either highly sensitive, or which ranged from low to negative sensitivities, deviated appreciably and in a consistent pattern from the average correlation line. It can be concluded that a laboratory test superior to the A. S. T. M. is still needed.

TANKER OUTPUT UP IN 1937

ABOUT 15 percent more tanker tonnage was launched in 1937 than in the previous year—according to statistics issued recently by Lloyd's Annual Register of Shipping—a world gain of 101,995 gross tons. Tankships represented about 29 percent of the world output of merchant vessels in 1937, the corresponding figures for the British Isles and United States being 16 percent and 60 percent.

WORLD TANKER OUTPUT

(Vessels of 1,000 gross tons and over)

Country	1937 Tons	1936 Tons
Germany	176,147	166,844
Great Britain and Ireland	144,556	148,797
United States of America	143,654	74,040
Japan	75,741	59,968
Sweden	71,841	98,035
Denmark	71,374	35,462
Holland	43,335	65,961
Other countries	43,096	18,687
World total	769,744	667,749

In reviewing these figures it should be borne in mind that they do not include the large number of contracts placed during 1937, for which the keels have not yet been laid down—these, together with orders already placed and pending this year, should make the 1938 total reach new high levels and improve the position of the United States.

GULF EXPORT PRICES FOR MAJOR OIL PRODUCTS

Products		Jan. 11	Jan. 18	Jan. 25	Feb. 1
		Cents Per Gallon			
GASOLINE:	U. S. Motor	5⅛	5	5	4⅞
	64/66-375 E.P.	5¼	5⅛	5⅛	5
	59 Octane and below	5⅛	5⅛	5⅛	5⅛
	65 Octane and above	5¾	5¾	5¾	5¾
AVIATION GASOLINE:	Gulf Export in cargo lots	9½	9½	9½	9
KEROSENE:	44 w.w.	5½	5½	5⅜	5⅛
	41/43 w.w.	5½	5⅛	5⅛	4⅞
	41/43 p.w.	5	5	5	4⅝
GAS OIL:	26-30 translucent	4¼	4¼	4¼	4
	30 plus translucent	4½	4½	4½	4⅛
		Dollars Per Barrel			
FUEL OIL:	Bunker C	95	95	95	95
	Cargo lots	85	85	85	82
	Diesel oil	1.90	1.90	1.90	1.90
		Cents Per Gallon			
LUBRICATING OIL:	Bright Stock No. 8	22½	22½	22½	22½
	Bright Stock No. 6½	22	22	22	22
	600 Warren E.	20½	20½	21	21
	600 Unfiltered s.r.	15	15	15½	15½
(New York Export Market)	650 Unfiltered s.r.	18	18	18½	18½
	600 Flash s.r.	18½	18½	19	19
	630 Flash s.r.	22½	22½	23	23
	Neutral 200 No. 3	24½	24½	24½	24½
	Neutral 150 No. 3½	22½	22½	22½	22½
(South Texas Export Market)	Red oil 500 No. 5-6	8¾	8¾	8¾	8¾
	750	9¼	9¼	9¼	9¼
	1200	9¾	9¾	9¾	9¾
	Pale oil 500	8¾	8¾	8¾	8¾
	750	9¼	9¼	9¼	9¼
	1200	9¾	9¾	9¾	9¾
		Dollars Per Barrel			
CRUDE OIL:	East Texas delivered at Gulf for export	1.50	1.49	1.49	1.49

FREIGHT RATES

	Dec. 22 Dirty	Dec. 22 Clean	Dec. 29 Dirty	Dec. 29 Clean	Jan. 3 Dirty	Jan. 3 Clean	Jan. 11 Dirty	Jan. 11 Clean
	Shillings Per Ton							
Gulf—U.K./Continent	26/-	35/-	26/-	35/-	25/-	34/-	25/-	34/-
California—U.K./Continent	—	—	—	—	—	no bookings	—	38/-
Aruba—U.K./Continent	22/-	28/-	22/-	28/-	22/-	28/-	22/-	28/-
North Atlantic—U.K. Continent	22/-	20 6	—	27 6	18/-	27/6	18/-	27-6

U. S. S. R.

Official Figures for Soviet Oil Operations

	Crude Production (Bbl.)	Daily Average (Bbl.)	Run to Stills (Bbl.)	Drilling (Ft.)
January	16,117,461	519,918	14,412,330	443,310
February	13,796,325	492,726	12,671,478	359,317
March	15,907,051	513,130	14,375,151	540,510
April	16,401,771	546,722	14,386,086	542,390
May	18,130,230	584,846	16,997,778	591,510
June	17,953,812	598,460	17,144,724	585,182
July	18,580,752	599,379	17,902,782	572,441
August	17,183,259	554,299	16,869,060	520,000
September	16,663,000	537,516	15,100,000	530,000
October	17,600,000	567,742	15,830,000	530,000
November	16,923,000	564,100	15,413,000	510,000
December	17,600,000	567,742	16,019,000	520,000
Total 1937	202,856,661	555,772	187,121,389	6,244,660
Total 1936	199,634,921	545,450	180,582,274	6,958,916
Total 1935	184,007,619	504,130	152,783,726	4,858,465
Quota 1937	234,450,000	642,329	208,285,000	9,240,000
Quota 1936	222,345,000	607,500	182,250,000	7,100,000
Quota 1935	221,106,000	605,769	178,605,000	5,214,000

FROM official figures available on Soviet oil operations it is evident that the total crude production for 1937 was slightly more than four percent above the corresponding figure for the previous year; it is to be assumed that the figure includes production of gas. In this case the 1937 total is bound to attain the 200,000,000 bbl. mark as predicted in these columns early in the year. No division of the Russian oil industry fulfilled its quota, and arrears of crude production amounted to several million barrels.

During November, 1937, the Soviets celebrated the 20th anniversary of the October Revolution and called attention to the industrial achievements of the ensuing period. The oil industry has been under Soviet rule for only 18 years, as the original nationalization decree of 1917 was revoked when Azerbaidzan declared itself independent and came under protection of the British, Turks and Germans. It was not until 1920 that the Soviet Red Armies came back to Baku and again nationalized the oilfields that the Soviets had anything to do with the oilfields. Drilling and production did not reach considerable proportions until 1923.

Soviet Oilfield Production

Year	Barrels
1913	67,315,860
1920	26,456,200
1932	155,927,997
1936	199,635,921
1937	202,856,661

Most of Russia's crude oil output is derived from formations tapped after nationalization of the existing fields of Czarist Russia or from entirely new fields which were discovered under Soviet rule.

About 78,000,000 bbl. of the 107,285,472

(Continued on page 80)

LIFE IS TOUGH
on sucker rod couplings

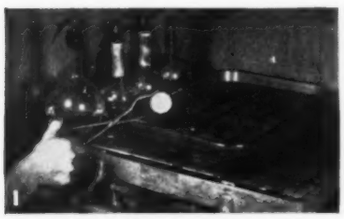
AXELSON'S CANDID CAMERA SHOWS HOW COUPLINGS ARE PREPARED FOR A LONG LIFE OF SERVICE IN AN OIL WELL

Wherever man pumps oil from the earth, Axelson Deep Well Plunger Pumps are busy night and day. Sucker rods, connected by hardened and ground couplings, join motive power on the surface with the pump thousands of feet below. Axelson's candid camera shows, step by step, the production of couplings and how they are built to give longer, more satisfactory field service.

Axelson production methods are the result of more than 46 years experience in the building of oil well equipment. Every laboratory test, every manufacturing operation, every plant test has but one objective,—namely, the production of a sucker rod coupling that will meet satisfactorily every field test required of it.

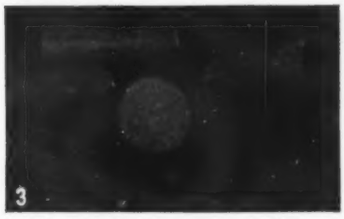
Chemical and metallurgical tests are made in Axelson laboratories on samples from every heat of coupling bar stock. Stock that does not meet Axelson specifications is rejected.

Each coupling is placed on an accurately threaded mandrel and faces are ground square with the thread. Thus Axelson reduces to a minimum the possibility of fatigue strains which reduce service life.



Wafer thin samples are cut from every piece of bar stock from which couplings are made and acid etched to verify specifications and to reveal any flaws existing in the raw material.

Blanks are placed in nichrome boxes and covered with carbonacious material, then heated in electric furnaces to carburize the surface to the proper depth of the coupling blanks.



Several specimens from each box are tested for depth of case which controls the depth of hardness of the finished couplings.

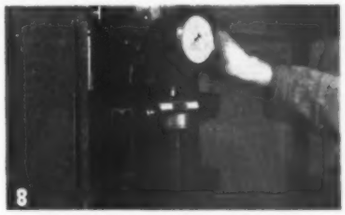
THERE IS NO ECONOMICAL SUBSTITUTE FOR QUALITY

Carburized blanks roll down the trough into this machine which automatically drills, rough reams, faces, and forms the radius of one end. The same process is repeated on the other end.

Wrench flats are next milled before couplings are hardened. At this point each coupling has been inspected six times and must pass seven more inspections before completion.

This automatically controlled furnace provides the particular heat treatment previously determined by laboratory test. After heating the couplings pass on into the quenching tank.

Drawing of couplings in the homo electric furnace relieves quenching strains. The carburized area is now very hard, offering greater resistance to abrasion and friction.



Immediately after the drawing operation and before the couplings are finished several couplings are selected at random from each lot and tested for Rockwell hardness.

Centerless grinding makes each coupling smooth, essential for frictionless operation within the tubing. Couplings are again inspected before they are passed on for finished machine work.

Form reamers (same length as coupling) finish each end and I.D. This operation assures the cone and bore being in alignment and also square with faces.

Between reaming and tapping all blank couplings are gauged with a blank taper gauge to verify that the reamed blank is perfectly concentric with each end and that the cone is correct.

Taps are run completely through the coupling on multiple spindle geared drill presses. The taps are released so that it is unnecessary to back them out risking distorted threads.

"Go" and "no-go" gauges hold Axelson couplings to rigid allowable A P I tolerances. Couplings are made up with Axelson rods at the plant to greater tension than they will meet in service.

A feeler gauge is used to inspect the faces of the shouldered couplings and to assure that these faces are square with the axis of the threads.

The couplings are washed in a hot spray washer and dried, after which they are dipped in a protective solution for rust prevention. They are then boxed for shipment.

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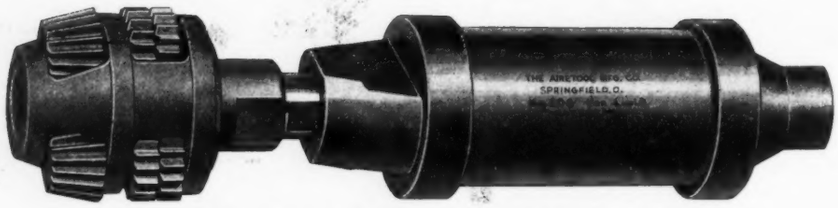

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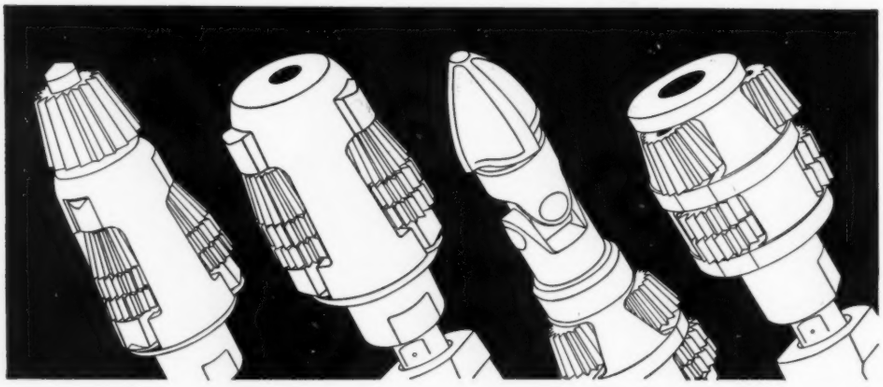

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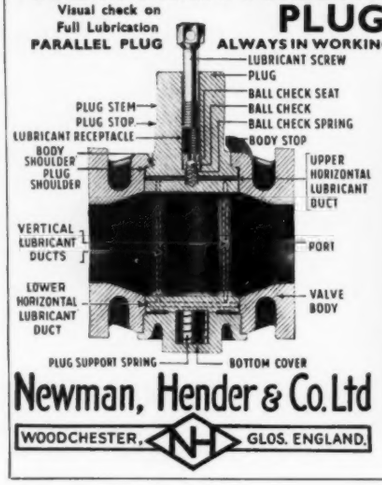

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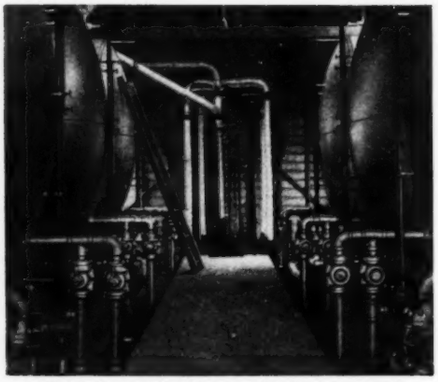


Installation showing N-M Valves on Gasoline Storage Tanks

(Continued from page 78)

bbl. of crude produced in 1936 from Soviet-discovered fields, were from oilfields which were discovered and opened for exploitation during the Second Piatiletka. Baku's output in that year was 149,910,102 bbl., of which 80,935,138 bbl. came from the new pools at Kala, Zikhi, Karachukur, Puta, and Lokbatan. This represents an increase in output in 1936 of almost 45 percent more crude than they yielded in 1913. Similarly, at Grozni the output from fields opened during the second Piatiletka amounted to 9,287,360 bbl. in 1936, compared with 8,800,488 bbl. for all Grozni in 1913. Maikop, which was under exploitation several years before the World War and which between 1910 and 1912 evoked a financial boom in Maikop oil shares on the London stock exchange, evidences the addition of new discoveries by the fact that 7,997,130 bbl. were produced in 1936 compared with a mere 616,940 bbl. in 1913. New areas in the Emba district brought into production include Baitchunas, Koschagil and South Iskin, from which 2,172,420 bbl. were obtained in 1936 against 852,930 bbl. in 1913.

During the latter part of the Second Piatiletka considerable geological prospecting was carried out and 41 new oil prospects studied, of which a number have come in already as commercial producers. Further regions were opened at Baku, Kala (Asisbekov), and Lokbatan.

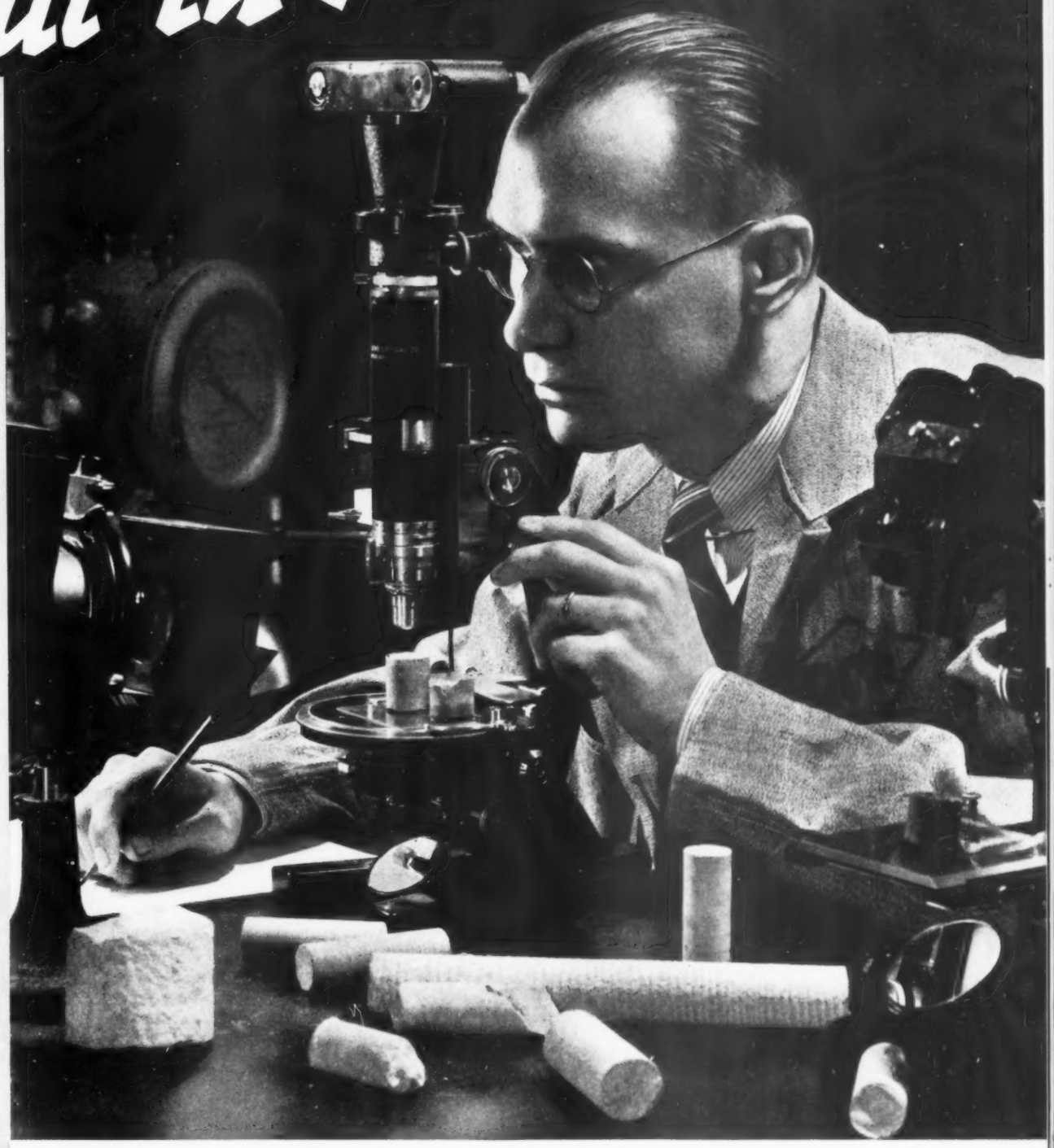
Considerable additions were made in Grozni, at Molgabek—which checked Grozni's decline and opened new possibilities in the Terski ridge. At Gudermes and Gorski Mountain of this group several flowing wells have been brought in, while new commercial prospects were opened in the Daghestan properties where Izberbash is of high potential value. Two more fields, Achisu and Kayakent, are of great promise. The Kuban Black Sea region, which was known as oil-bearing in pre-war days, has undergone a thorough study and new oilfields of appreciable extent were opened by Soviet operators at Kutais, Kurazepe, Asphalt Mountain, Kesslerovo and Adagum.

New oilfields were discovered at Uzbekhstan, Middleasia, in the south of which Haudag and Utchkilzil are producing properties and more recently Andizhan has proven a promising oilfield.

To the East, in addition to Ishimbayevo, the Tuimasi region is favorable and new fields were established at Prikamsk, in the Sverdlovsk district. At Sizran of the Middle Volga plains region an oilfield was opened and its production included in the plans for 1938. At Buguruslan, in the region of Orenburg, commercial quantities of oil were produced. On the island of Sakhalin

(Continued on page 82)

Out in Front



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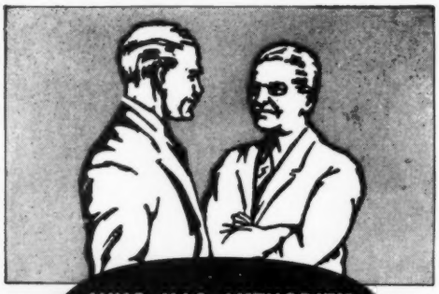

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(Continued from page 80)

a new oilfield has recently come in—at Ekhabi.

Considerable increases have also taken place in production of gas. Whereas gas output in 1932 amounted to 879,000 tons, the plans for 1937 called for 2,340,000 tons. Special drilling is being carried on in regions where gas deposits are reported to exist.

Soviet Drilling Progress

Period	Feet
1913	912,780
1920-1921	19,470
1925-1926	950,070
1931	2,334,420
1933	2,757,150
1934	4,950,000
1935	4,858,465
1936	6,958,916
1937	6,244,660

Deeper drilling has become a common practice in Soviet oilfields and at Baku drilling into the Lower Kirmakin layers requires, on the average, 7,260 ft. depth. In several instances depths of 9,240 ft. were drilled.

The average speed in 1913 amounted to 115 ft. per outfit per month. The high speed indexes show little, if the useful time in drilling is considered. The figures for 1936 show 68.3 percent of all drilling time used in drilling proper, while of the 31.7 percent of time losses exactly 14.3 percent of drilling time losses were breakdowns, taking up 470,818 hours of drilling time.

In drilling, as in production, no equipment is imported and requirements are being supplied by domestic machine shops. Some at Baku are making powerful four-speed hoists for drilling to 10,000 ft., as well as power pumps, rotary tables, swivels and other types of equipment. Recently some new units were designed and called the "United type". These are being manufactured by the domestic machine shops on a large scale and are copies of several American types combined.

Progress has been made in refining during the period. The old batch type shell stills have practically disappeared and pipe stills were erected in their stead together with a large bright stock installation and many cracking units. The total input capacities have grown from 62,175,400 bbl. in 1927-28 to 113,207,600 bbl. in 1930, and from 173,411,000 bbl. in 1936 to almost 200,000,000 bbl. in 1937. Deeper cuts are being made from the crude potential and the throughput is being used to greater advantage. Large refineries were erected at points near consuming centers and also near prospective oilfields.

With the close of 1937 has also come to an end the second Piatiletka; though official figures of operation are still lacking the total results for the year as well as for the whole period are below expectation. Lack of data and figures may be due to the fact that the Trotzki-Bukharin wrecking, of which some of the highest officials in many government

(Continued on page 84)

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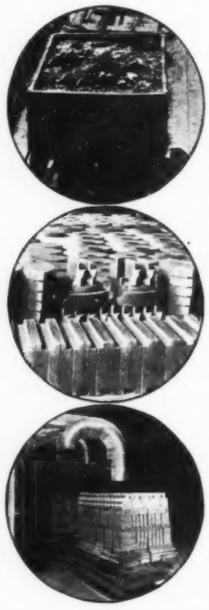

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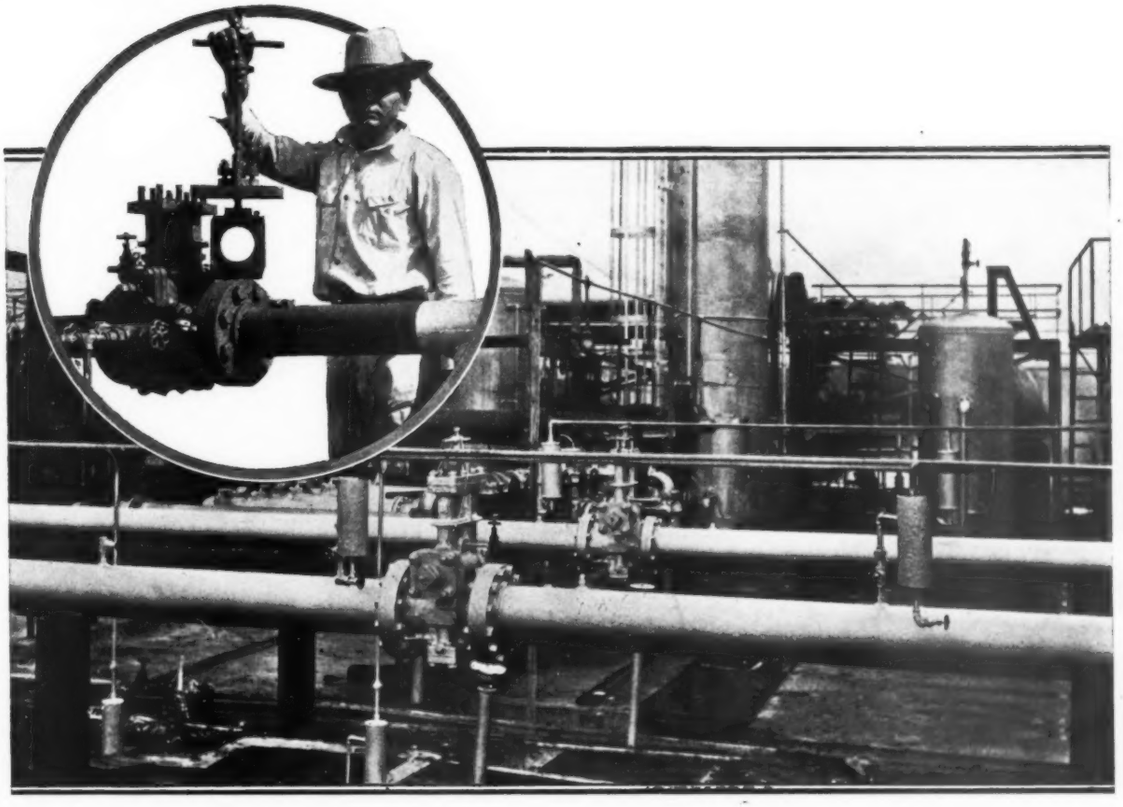

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(Continued from page 82)

departments were accused, was also responsible for sabotage in the making up of summaries for past operations, just as they are responsible, according to accusations, for not making up schedules and quotas for the Third Piatiletka.

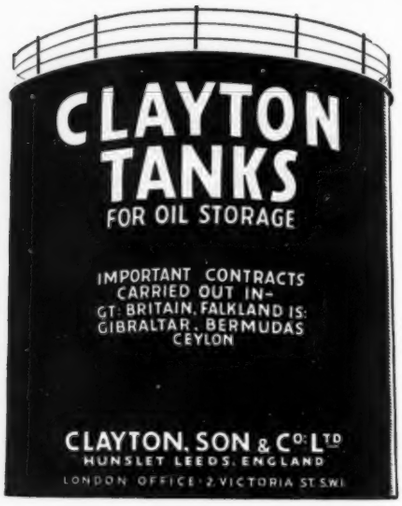
Trouble was reported in the State Planning Commission early in 1937 and this culminated in the removal of many high officials from the commission as enemies of the people and of the state. V. Mezhlauk, who succeeded Ordzonikidze as Commissar for Heavy Industries, came in disfavor and was dropped from the Commission which he one time headed. Accusations against several members included charges of delay in making charts of operations completed and drafts for further annual and quarterly plans for National Economy.

The Third Piatiletka will be similar to the preceding two and is intended to make the wheels of Soviet industries turn faster and labor produce more goods in order to meet the increasing demands and needs of the country. The operation of industries will have to show growth, but recently industrialization has been somewhat slowed down. The reasons for this slowing down may be many, but the most important are the prevailing conditions under which plan fulfillment had been laboring in recent years. Purges have eliminated too many expert executive and engineering forces while their places were taken by young graduates trained in haste and without experience. Fear of responsibility and prosecution for mistakes may have become a factor of the slowing down.

Another important factor is the general deteriotation of machinery. The army of Stakhanovites accelerated operation of all machinery beyond capacity in order to catch up with plans or failing records, and this together with irrational handling of the tools and laxity of labor might have caused more harm than good.

It is understood that all the engineering on the Lummus cracking unit, ordered in 1936 has been completed and all equipment shipped sometime ago. Construction of the plant was delayed by the Soviet Government, but it is reported that Mr. V. E. Hanson of the Lummus Company who will be in charge of construction has made arrangements to leave the United States the end of February in order to arrive in Russia and superintend the beginning of construction. In regard to the pipestill, ordered from Alco Products in 1936, engineering and shipment of equipment was completed long ago; but, here again, construction of the plant has never been completed due to failure of the Russians to supply steel and labor necessary for completion.

J. WEGRIN



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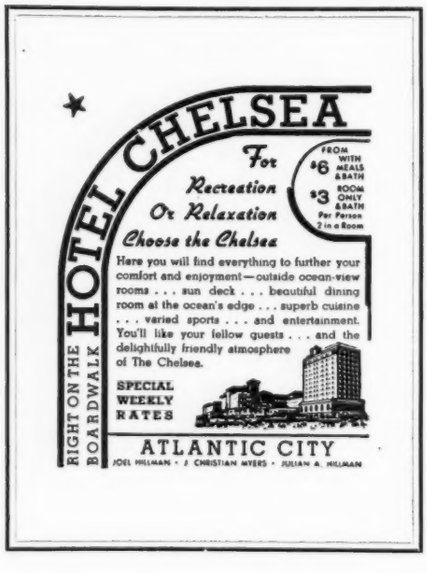
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